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Facial Aesthetics And Soft Tissue Changes Following Orthodontic Treatment: A Review

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Abstract

Facial esthetics has become a central focus in modern orthodontics, extending treatment objectives beyond occlusal correction to optimizing soft-tissue harmony and patient psychological well-being. Facial attractiveness is influenced by an intricate interplay between skeletal morphology, dentoalveolar positioning, and the overlying soft-tissue envelope, which responds dynamically to orthodontic forces. Orthodontic interventions including extraction and non-extraction therapy, fixed appliances versus clear aligners, orthognathic surgery, growth modification, and temporary anchorage devices produce predictable soft-tissue and skeletal adaptations that modulate lip posture, smile dynamics, and facial convexity. Advances in three-dimensional imaging, Digital Smile Design, and AI-based predictive modeling facilitate personalized treatment planning by integrating facial proportions, dynamic smile analysis, and patient-specific soft-tissue responses. Esthetic outcomes are further influenced by gender, age, and ethnic variations, necessitating culturally and demographically sensitive approaches. By prioritizing soft-tissue–driven, patient-centered planning, modern orthodontics enhances facial harmony while positively impacting self-esteem, social perception, and oral health-related quality of life.

Keywords: Facial Esthetics, Orthodontics, Soft-Tissue Adaptation, Digital Smile Design, Patient-Centered Care.

Introduction

Facial esthetics in orthodontics refers to the harmonious balance and proportional relationships among facial features influenced by underlying dental and skeletal structures. It has become a central focus of modern orthodontic practice, as treatment goals have evolved beyond achieving ideal occlusion to enhancing overall facial appearance and psychological well-being.[1] The concept encompasses macroesthetics (facial proportions), miniesthetics (smile dynamics), and microesthetics (tooth-level details), which together define dentofacial attractiveness. Optimal esthetic balance is attained when facial symmetry, proportionality, and the soft-tissue drape align naturally with dental alignment and occlusal function. Historically, Edward H. Angle's early orthodontic philosophy in the late 19th century prioritized occlusal relationships under the assumption that correcting malocclusion inherently ensured facial harmony. However, subsequent cephalometric studies and clinical observations in the mid-20th century demonstrated that soft-tissue adaptation often occurred independently of skeletal or dental corrections, prompting a paradigm shift.[1] In 1999, Ackerman and Proffit articulated the "soft-tissue paradigm," emphasizing that treatment planning should prioritize facial form and soft-tissue harmony over rigid occlusal ideals. This evolution led to the modern understanding that orthodontic interventions must be individualized to complement natural facial contours and esthetic diversity.[1] Contemporary treatment planning now integrates facial analysis as a diagnostic cornerstone, employing cephalometric assessments, 3D imaging, and golden proportion evaluations to guide decisions regarding extractions, incisor inclination, orthognathic surgery, and aligner therapy each chosen for its influence on facial proportions, lip posture, and nasolabial harmony rather than mere occlusal alignment.[2] The improvement of facial esthetics following orthodontic treatment also plays a crucial role in enhancing psychological well-being, as numerous studies have shown that patients experience increased self-confidence, improved social perception, and higher oral health–related quality of life (OHRQoL) after esthetic enhancement. Key soft-tissue parameters influenced by orthodontic interventions include upper and lower lip retrusion following incisor retraction, which improves profile convexity and lip balance relative to the esthetic line; increased nasolabial angle enhancing nasal–lip harmony; slight forward chin projection contributing to facial straightness; and modest reductions in lip height and volume that refine the perioral region. Furthermore, vertical proportionality often improves, particularly in extraction cases where decreased lower facial height enhances esthetic harmony.[3]

Review of Literature

A cross-sectional survey by Panaite et al. involving 450 orthodontic patients reported that enhanced self-confidence and improved smile perception (r = 0.62) were the most significant predictors of overall treatment satisfaction, outweighing technical aspects such as appliance type or discomfort levels.[4] The study highlighted that effective orthodontist–patient communication and clear articulation of esthetic goals positively influenced satisfaction (r = 0.58, $p = 0.002$), whereas high treatment costs (r = −0.41) and social embarrassment during appliance wear (r = −0.47) negatively impacted perceived outcomes. In a three-dimensional scanning study on 80 adult women[5], Cao Yabo et al. demonstrated that extraction therapy induced more pronounced alterations in the nasolabial angle and reductions in lip and chin volume, whereas non-extraction treatments led to greater changes in facial height and lip width. The increase in nasolabial angle was attributed to anterior teeth retraction. The study underscored the capability of 3D facial scanning to quantify linear, angular, and volumetric variations, thereby facilitating individualized orthodontic treatment planning based on facial morphology. Tanpure et al. (2024)[6] observed a substantial reduction in dental crowding (mean 5.2 mm) following orthodontic intervention, accompanied by notable soft tissue improvements, including an average lip advancement of 3.8 mm and enhanced lip thickness. Furthermore, Aboobacker et al. (2025) reported that maxillary advancements in Class III malocclusion patients led to improved soft-tissue contours and increased nasal prominence, contributing to better overall facial profiles.[7] Gao et al. (2022) emphasized that facial morphology significantly affects soft tissue adaptation. Variations in the nasion–menton ratio, occlusal height, and dental arch width were identified as key determinants of treatment-induced soft tissue changes. Patients with wider and shorter facial forms were found to be more susceptible to adverse esthetic outcomes.[8]

Determinants of Facial Esthetics

Facial esthetics in orthodontics is shaped by the intricate interplay between skeletal morphology, dentoalveolar positioning, and the overlying soft-tissue envelope. Through objective quantification using anthropometric and cephalometric analyses, clinicians can design individualized treatment plans that achieve harmonious, symmetrical, and proportionate facial profiles.[9] The key determinants of facial esthetics include the skeletal foundation, which establishes vertical and sagittal proportions through maxillary and mandibular relationships; dentoalveolar position, particularly the inclination and placement of incisors that directly affect lip posture and smile dynamics; and the soft-tissue envelope, whose characteristics such as lip fullness, muscle tone, subcutaneous fat, and skin elasticity define external facial contour.[10] Proportionality and symmetry reflected in balanced vertical thirds and transverse harmony further influence perceived attractiveness. Cephalometric evidence demonstrates that facial esthetics is not limited to skeletal alignment but emerges from an integrated relationship among multiple systems, as variations in facial height, ANB angle, and incisor inclination significantly influence nasolabial and mentolabial profiles. Studies employing canonical correlation analysis have shown that approximately 84% of soft-tissue variability is explained by underlying hard-tissue anatomy, underscoring the importance of skeletal positioning particularly of the upper and lower incisors in determining lip length, thickness, and projection.[11] However, the visible outcome is modulated by soft-tissue adaptability, which can either conceal or exaggerate skeletal discrepancies; hence, relying solely on skeletal cephalometric norms cannot ensure optimal esthetic enhancement without accounting for soft-tissue behavior. Ethnic and gender variations also play a crucial role, as individuals with thicker lips or bimaxillary protrusion often display less pronounced visible change per unit of skeletal correction than those with thinner soft tissues. Contemporary assessment integrates anthropometric ratios such as facial thirds, intercanthal and nasal widths, and facial index with cephalometric parameters including ANB angle, FMA, Wits appraisal, E-line distances, and nasolabial angle.[12] The principles of the balanced profile, golden proportion, and facial symmetry further guide esthetic assessment, where the nasal tip, lips, and chin align harmoniously along the esthetic (E) line to create a straight or mildly convex profile with pleasing nasolabial and labiomental angles. The golden proportion (1:1.618) mathematically defines natural beauty, suggesting that ideal facial length is approximately 1.6 times its width, the vertical thirds of the face are equal, and the lower lip should be about 1.6 times the fullness of the upper lip.[13] While perfect symmetry enhances attractiveness by reflecting developmental stability, minor asymmetries within biological norms contribute to a more natural and authentic appearance. Clinically, understanding these determinants enables orthodontists to integrate technical tooth movement with overall facial harmony, prioritizing esthetic integration over mere occlusal correction.[14] With rapid advances in AI-assisted cephalometry and 3D anthropometric modeling, orthodontic treatment planning is increasingly capable of delivering personalized, predictable, and esthetically balanced facial outcomes.[15]

Soft Tissue Adaptation During Orthodontic Tooth Movement

Soft tissue adaptation during orthodontic tooth movement represents a complex, dynamic process of biological and biomechanical remodeling that integrates changes within the periodontal ligament (PDL), alveolar bone, and perioral soft tissues in response to controlled orthodontic forces. The biological basis of this adaptation lies in the strain-induced cellular responses within the PDL, which serve as the mechanotransductive interface between applied forces and skeletal remodeling.[16] When orthodontic force is applied, distinct compression and tension zones are established within the PDL, stimulating fibroblasts, osteocytes, and endothelial cells to initiate a cascade of osteoimmunologic signaling. Pro-inflammatory mediators such as interleukin-1β (IL-1β), tumor necrosis factor-α (TNF-α), prostaglandins, and vascular endothelial growth factor (VEGF) regulate osteoclastogenesis at compression sites and osteoblastic recruitment at tension sites, thereby driving bone resorption and apposition in a coordinated manner. This remodeling follows three kinetic phases—initial displacement, lag phase involving cellular recruitment, and a phase of linear acceleration characterized by synchronized bone turnover and soft-tissue adaptation. As these underlying skeletal and alveolar modifications occur, the overlying soft-tissue matrix—including muscles, skin, and fibrous connective structures undergoes reorganization to maintain both esthetic and functional equilibrium through extracellular matrix mechanotransduction.[17]

Orthodontic tooth movement, particularly anterior retraction, induces distinct alterations in perioral muscle tone and contour. The orbicularis oris, mentalis, and depressor labii muscles adapt to changes in alveolar projection, leading to decreased lip strain and modified vermilion display.[18] Clinical and three-dimensional morphometric studies consistently document nasolabial fold deepening with upper incisor retraction, especially in extraction cases where midfacial support diminishes; concurrent thickening or anterior–inferior displacement of chin soft tissues enhances the definition of the mentolabial fold. Quantitatively, upper lip thinning averages 0.6–1.1 mm for each millimeter of incisor retraction, accompanied by a measurable reduction in labial convexity due to muscle relaxation and connective tissue remodeling.[19]

The upper and lower lips exhibit differential adaptive responses owing to anatomical and muscular distinctions. The upper lip typically undergoes partial retraction approximately 40–50% of the magnitude of incisor movement because of its structural integration with the nasolabial complex and limited elasticity of the philtrum.[20] This produces a flatter facial profile, an increased nasolabial angle, and reduced vermilion exposure. In contrast, the lower lip demonstrates greater mobility, adapting to nearly 60–80% of lower incisor displacement due to its association with the mentalis and depressor labii muscles, thereby enhancing chin projection and decreasing labiomental angle depth.[21]

Effects of Orthodontic Interventions on Facial Esthetics and Soft-Tissue Morphology

Orthodontic interventions exert diverse morphological and esthetic effects on the face, modulating facial convexity, lip posture, smile dynamics, and overall soft-tissue equilibrium depending on the chosen treatment approach. Recent systematic reviews and clinical investigations (2023–2025) have elucidated these distinctions, emphasizing the need for individualized, esthetically driven treatment planning. Extraction versus non-extraction therapy represents one of the most debated aspects of orthodontic strategy. Four-premolar extraction protocols typically result in measurable reductions in lip prominence, decreased facial convexity, and increased nasolabial angle, with a 2023 meta-analysis reporting mean decreases in maxillary and mandibular inter-first molar widths by approximately 2 mm each.[22] Such therapy often produces a flatter facial profile due to incisor retraction, enhancing chin projection and nasolabial harmony by an average of 4–6°, particularly benefiting patients with initial bimaxillary protrusion. Conversely, non-extraction treatment tends to preserve arch width and midface fullness, maintaining natural lip support and contributing to a more convex, youthful appearance. While concerns of a “flattened profile” persist, current evidence suggests that undesirable midface flattening occurs mainly in borderline cases or when retraction exceeds esthetic limits; hence, extraction decisions should be guided by facial analysis, skeletal class, and lip morphology rather than space considerations alone.[23]

Differences in esthetic outcomes are also observed between fixed appliance therapy and clear aligner systems. Clear aligners generally preserve the smile arc more effectively, maintain harmonious incisal curvature relative to the lower lip, and provide superior control over incisor inclination, thus optimizing gingival display and smile dynamics. In contrast, fixed appliances while offering enhanced precision in complex movements may transiently flatten the smile arc due to vertical elastics or bracket-induced leveling effects. Furthermore, aligner therapy is associated with reduced gingival inflammation, improved lip line uniformity, and higher patient-reported satisfaction regarding midfacial esthetics during active treatment.[24]

In cases requiring skeletal correction, orthognathic and growth modification treatments produce profound changes in both hard and soft tissues. Mandibular advancement procedures, such as bilateral sagittal split osteotomy, significantly increase chin projection, reduce facial convexity, and improve the mentolabial angle by approximately 10–15°, while maxillary impaction diminishes lower facial height and induces favorable counterclockwise mandibular rotation, enhancing smile esthetics and tightening the nasolabial angle.[25] Bimaxillary surgeries, combining maxillary advancement with mandibular setback, yield the most balanced outcomes by harmonizing midface projection and chin position for optimal facial symmetry. Among adolescents, functional appliances such as the Herbst, Twin-block, and MARA capitalize on active growth to remodel the condyle and reposition the mandible anteriorly, thereby advancing the pogonion, improving lower lip support, and reducing overjet. Early orthopedic intervention, guided by the functional matrix theory, fosters skeletal–soft tissue coadaptation and minimizes the likelihood of future surgical correction.[26]

Additionally, the incorporation of temporary anchorage devices (TADs) and miniscrews has revolutionized orthodontic biomechanics by allowing precise vertical and sagittal control independent of reciprocal anchorage effects.[27] During anterior retraction, miniscrew-supported mechanics minimize molar extrusion and maintain the mandibular plane angle, preventing undesirable downward and backward mandibular rotation. The resulting soft-tissue profiles demonstrate greater stability, preserving nasolabial balance and preventing excessive upper lip retraction. In patients with vertical growth tendencies or gummy smiles, TAD-assisted intrusion mechanics further enhance lip–chin proportionality and vertical facial harmony.[28]

Enhancing Facial Esthetics and Psychological Well-being through Personalized Orthodontic Care

Smile esthetics encompass both static and dynamic components—ranging from tooth alignment, gingival contour, and buccal corridors to lip movement, smile arc, and gingival display—all of which collectively define facial attractiveness. The smile arc, representing the curvature harmony between the upper incisal edges and the lower lip, contributes significantly to a youthful appearance, while optimal buccal corridors enhance smile width and fullness. Conversely, excessive gingival display or asymmetry can detract from visual appeal.[29] Modern advancements such as three-dimensional (3D) imaging, Digital Smile Design (DSD), and AI-driven facial analysis have transformed orthodontic planning by allowing clinicians to simulate patient-specific outcomes that integrate dental alignment, facial proportions, and dynamic soft-tissue responses. Through 3D facial scans, CAD/CAM workflows, and AI-assisted modeling, DSD enables precise visualization and communication of anticipated esthetic changes, aligning clinical outcomes with individualized facial harmony and patient expectations.[30] Moreover, soft tissue characteristics vary considerably with gender, age, and ethnicity females often exhibit thinner lips and heightened esthetic expectations, while aging leads to reduced tissue elasticity and facial volume that may influence long-term post-treatment stability. Ethnic variations further shape esthetic ideals, necessitating culturally sensitive orthodontic planning; for instance, East Asian patients may prefer subtler lip retraction compared to Western norms. Sustained soft-tissue adaptation and skeletal stability are vital for maintaining facial balance over time, even as natural aging occurs. Importantly, esthetic enhancement through orthodontics extends beyond physical transformation it significantly impacts psychological well-being, with patients frequently reporting heightened self-esteem and satisfaction.[31] Studies indicate that laypersons value natural, symmetrical, and proportionate smiles more than overly idealized corrections, underscoring the need for realistic, patient-centered esthetic goals. Therefore, integrating digital diagnostics, demographic sensitivity, and dynamic smile analysis ensures orthodontic interventions that not only refine facial esthetics but also enrich patient confidence and emotional health.[32]

Conclusion

The growing emphasis on standardized esthetic indices highlights the need for objective and reproducible evaluation of facial outcomes in orthodontics. The integration of AI and digital twin models now enables precise prediction and simulation of esthetic changes, allowing truly personalized treatment guided by facial harmony rather than dental alignment alone. As orthodontic therapy profoundly influences both soft-tissue contours and skeletal balance, the modern paradigm prioritizes soft tissue–driven, patient-centered planning that unites function, esthetics, and emotional well-being for comprehensive facial enhancement.

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