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Tracing the transformation: A comprehensive review of craniofacial growth from childhood to adulthood (5-25 Years)

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Abstract
Craniofacial growth from early childhood to young adulthood (ages 5 to 25) encompasses a critical developmental phase that shapes the facial skeleton, dental arches, and soft tissue contours. These changes occur in well-defined stages influenced by genetic patterns, hormonal shifts, and environmental modifiers. Orthodontists must understand these processes to guide treatment timing, manage growth imbalances, and achieve stable, esthetic, and functional outcomes. This comprehensive article integrates fundamental growth concepts with in-depth, age-specific changes in hard and soft tissue morphology, presenting clinical implications essential for growth-based orthodontic intervention.

Keywords: Elastic modulus, flexural strength, provisional restorative materials

Introduction
Craniofacial growth is central to the specialty of orthodontics. Successful diagnosis and treatment outcomes depend on the clinician's ability to predict, influence, and align with the natural progression of facial growth. Growth is not a uniform or simultaneous event but rather a sequence of tissue-specific changes occurring over time. The age range of 5 to 25 years marks a biologically active period involving significant skeletal, dental, and soft tissue modifications.
This article offers a descriptive narrative of the craniofacial changes across different tissues, integrating insights from growth biology, cephalometric analysis, and clinical observations to provide a reliable reference for orthodontists managing patients during the growth phase.

1. Basic Concepts of Growth
Growth in the craniofacial region is a dynamic and biologically regulated process involving a combination of cellular proliferation, differentiation, and remodeling. In orthodontics, it is vital to distinguish between incremental growth, which adds new tissue, and remodeling, which changes shape through bone deposition and resorption. These combined processes allow facial bones to not only enlarge but also shift in position to achieve functional balance.
The cephalocaudal gradient highlights how growth initiates in the cranial vault and moves progressively downward. This is why the neurocranial components (e.g., braincase and upper face) develop and reach adult proportions much earlier than the viscerocranium (lower jaw and facial skeleton). This anatomical sequence means that treatments targeting the maxilla often yield better skeletal outcomes when done earlier, whereas mandibular modifications may require sustained treatment or delayed intervention due to later growth completion.

Scammon's Growth Curves illustrate the relative maturity of various tissue systems:
- The **neural system** reaches ~95% of adult size by age 7, making the head appear disproportionately large in young children.
- **General body tissues**, which include the skeletal and muscular systems, grow steadily and show a distinct pubertal spurt.

- The genital system remains dormant until puberty and then accelerates rapidly, influencing jaw and chin growth due to hormonal effects.
- The lymphoid system (tonsils, adenoids) enlarges rapidly in early years and involutes during adolescence, often impacting airway and breathing patterns that influence vertical growth patterns.

Understanding these patterns allows orthodontists to anticipate facial form development and to intervene with orthopaedic appliances during optimal growth periods.

1.1 Cephalocaudal Gradient

This principle states that growth proceeds from the head downward. The cranial vault matures early (by age 7-8), while the face, especially the mandible, continues to grow well into the third decade. Thus, mandibular interventions require a longer observation period compared to the maxilla.

1.2 Scammon's Growth Curves

These illustrate how different tissue systems grow:

- Neural tissues (e.g., brain, upper face): peak early.
- General tissues (muscle, bone): show a steady S-shaped curve.
- Genital tissues: minimal growth until puberty, then rapid.
- Lymphoid tissues: early enlargement followed by involution.

The craniofacial skeleton follows the general growth curve, making it ideal to intervene orthopedically during the peak pubertal growth phase.

2. Craniofacial Growth Phases (5-25 Years)

Craniofacial growth during this two-decade period can be organized into three main developmental stages, each characterized by specific skeletal and soft tissue changes.

Phase I: Childhood Growth (5-10 Years)

During this period, growth is gradual and largely horizontal. The maxilla undergoes forward and downward displacement along with the cranial base, allowing for the eruption of the permanent incisors and first molars. The mandibular body increases in length, but the growth rate of the condylar process remains slow. Facial convexity is still prominent due to underdeveloped mandibular projection. The nasomaxillary complex matures more rapidly than the mandible, making early diagnosis of maxillary deficiencies particularly important.

Clinical note: This is the ideal time for interceptive orthodontics to correct developing crossbites, habits, and arch form discrepancies.

Phase II: Pubertal Growth Spurt (10-15 Years)

This stage is marked by the most rapid and significant changes in craniofacial morphology, especially in the mandible. The pubertal growth spurt is typically earlier in females (10-12 years) than in males (12-14 years). The mandible exhibits both vertical and anteroposterior growth, primarily through condylar elongation. Maxillary growth slows down relative to the mandible, which often improves Class II profiles naturally.

Facial height increases, especially in vertical growers, leading to elongation of the lower third of the face. Boys often show more pronounced chin development due to later and longer mandibular growth. This stage offers the most favorable time for using functional appliances such as twin blocks or Herbst appliances.

Clinical note: Cephalometric superimposition during this phase shows the greatest skeletal change, particularly mandibular advancement and vertical alveolar development.

Phase III: Post-Adolescent Growth (15-25 Years)

After the adolescent growth spurt, skeletal changes slow down, but they do not entirely cease. Mandibular growth can persist into the early 20s, especially in males. Subtle modifications in chin projection and ramus height may continue, often leading to late-onset Class III malocclusions or anterior open bites.

Soft tissue growth, particularly of the nose, chin, and lips, continues and significantly impacts facial esthetics. The nasolabial angle may flatten, and the mentolabial sulcus becomes more defined. The mandible's residual growth during this phase can be difficult to predict, which has implications for retention planning and post-treatment stability.

Clinical note: Orthognathic surgery should ideally be planned after this stage to ensure skeletal maturity.

3. Hard Tissue Changes

The hard tissues of the craniofacial complex (maxilla, mandible, and cranial base) exhibit predictable changes in both linear dimensions and angular relationships, which are important for diagnosis and treatment planning.

3.1 Maxillary Growth

The maxilla grows through:

- Sutural displacement at the frontomaxillary, zygomaticomaxillary, and pterygopalatine sutures
- Surface remodeling, primarily through apposition at the tuberosity and resorption at the anterior nasal spine

This downward and forward growth allows for the sequential eruption of permanent teeth and proper development of the midface. However, maxillary growth tends to complete earlier (by 14 years in females, 16 in males), making early orthopedic interventions such as headgear or face mask therapy most effective in this window.

3.2 Mandibular Growth

Mandibular growth occurs at the condylar cartilage and through apposition on the posterior borders of the ramus and gonial angle. The mandible grows longer, deeper, and taller:

- Co-Gn (Total length) increases dramatically during adolescence
- Ramus height (Co-Go) increases vertically
- Corpus length (Go-Pg) increases in horizontal growers

The direction of growth (forward in horizontal growers, downward in vertical growers) influences facial type, dental relationships, and esthetics.

3.3 Angular Cephalometric Changes

- **SNA angle (~82°):** Slightly decreases as nasion moves forward.
- **SNB angle (~80°):** Increases due to mandibular advancement.
- **ANB angle:** Decreases over time due to differential mandibular growth. Values >4° indicate skeletal Class II; <0° indicate Class III.
- **Gonial Angle**: Smaller in hypodivergent cases; larger in

vertical patterns.
- **Articular Angle**: Reflects mandibular positioning relative to cranial base.

3.4 Vertical and Sagittal Dimensions
Facial height ratios become more balanced in well-growing individuals. Imbalance, such as increased lower facial height, often requires vertical control mechanics or orthognathic planning in future.

4. Dental Arch Changes
Dental arches develop not only through tooth eruption but also via skeletal base expansion and alveolar bone growth.

4.1 Arch Width
- **Intercanine Width:** Increases until age 13 and then remains stable or narrows.
- **Intermolar Width:** Initially increases but may decrease slightly post-adolescence due to molar mesial drift.

Arch form stability is influenced by skeletal pattern. Hypodivergent individuals tend to have broader, more stable arches, while hyperdivergent patients often show narrowing with age.

4.2 Arch Length
a. Decreases over time due to:
- Mesial migration of molars
- Loss of leeway space
- Incisor uprighting and interproximal wear

Orthodontic planning must consider the natural decrease in arch length, especially in borderline extraction cases.

5. Soft Tissue Changes
Soft tissues not only reflect skeletal development but also influence smile esthetics, lip seal, and treatment planning.

5.1 Nasolabial Angle
- Ideal range: 90°-110°
- Influenced by upper incisor inclination and nasal tip projection
- Becomes more obtuse with age due to nasal growth and maxillary remodeling

5.2 Lip Morphology
- Upper lip increases in length and thickness, particularly during adolescence
- Lower lip becomes more prominent as the chin grows forward
- Lip strain and competency are more commonly affected in vertical growth patterns
- Horizontal growers exhibit fuller lips and improved seal post-treatment

5.3 Chin and Lower Face
- Chin projection improves with skeletal maturity and soft tissue thickening
- Soft tissue pogonion becomes more anterior, contributing to facial balance
- The mentolabial sulcus deepens, often improving facial profile convexity

These changes must be anticipated when planning incisor retraction or orthognathic procedures.

6. Facial Type Stability
Facial types typically stabilize by adolescence but may change in 20-25% of cases due to late growth or external factors.
- Hypodivergent (Short face) individuals often retain strong musculature and flatter mandibular planes.
- Hyperdivergent (Long face) types are more prone to open bites, lip incompetency, and vertical maxillary excess.
- Average (Normodivergent) patterns have the most balanced facial height and esthetic harmony.

Changes can result from
- Hormonal surges during puberty
- Environmental influences like mouth breathing or tongue posture
- Late mandibular growth spurts

Predicting facial type shifts is critical for managing retention and long-term stability.

7. Clinical Implications for Orthodontics
A deep understanding of craniofacial growth patterns enables orthodontists to:

Time interventions effectively:
a. Functional appliances during pubertal growth
b. Maxillary protraction in early mixed dentition

- Modify growth patterns with orthopedic forces or growth modulation appliances
- Plan retention protocols tailored to individual growth trends (e.g., long-term retention in vertical cases)
- Enhance facial esthetics by controlling incisor inclination, soft tissue profile, and lower facial height

Late mandibular growth, especially in Class III and vertical growers, must be monitored to avoid relapse or instability post-treatment.

Conclusion
Craniofacial growth between the ages of 5 and 25 is a complex and multi-phased process involving coordinated changes in skeletal, dental, and soft tissue structures. Understanding these age-specific transformations is essential for accurate diagnosis, optimal treatment timing, and long-term orthodontic stability. While the maxilla tends to complete growth earlier, the mandible continues to grow well into young adulthood, influencing facial balance and occlusion. Dental arches evolve in width and length, while soft tissues progressively shape the visible facial profile. The type and direction of growth—whether vertical, horizontal, or average—significantly affect treatment outcomes and relapse potential. Therefore, a thorough grasp of craniofacial development equips clinicians with the insight to design individualized, growth-adapted treatment plans that align with both functional and esthetic goals.

Conflict of Interest
Not available

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References

1. Broadbent BH. A new X-ray technique and its application to orthodontia. Angle Orthodontist. 1931;1(2):45-66.
2. Enlow DH, Hans MG. Essentials of Facial Growth. Philadelphia: W.B. Saunders; 1996.
3. Björk A. Prediction of mandibular growth rotation. American Journal of Orthodontics. 1969;55(6):585-599.
4. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. 6th ed. St. Louis: Elsevier; 2019.
5. Buschang PH, Martins J. Growth of the maxillary and mandibular skeletal bases in untreated individuals. American Journal of Orthodontics and Dentofacial Orthopedics. 2006;130(6):789-798.
6. Nanda R. Biomechanics and Esthetic Strategies in Clinical Orthodontics. St. Louis: Elsevier; 2005.
7. Riolo ML, Moyers RE, McNamara JA, Hunter WS. An atlas of craniofacial growth: cephalometric standards from the University School Growth Study, The University of Michigan. Monograph 2, Craniofacial Growth Series, Center for Human Growth and Development, University of Michigan; 1974.
8. Behrents RG. Growth in the aging craniofacial skeleton. [Ph.D. Thesis]. University of Michigan; 1985.
9. Subtelny JD. The soft tissue profile, growth and treatment changes. Angle Orthodontist. 1959;29(3):105-122.
10. Ricketts RM. Cephalometric analysis and facial aesthetics. American Journal of Orthodontics. 1960;46(9):647-673.

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