BÖLÜM 2

Büyüme ve Gelişim

Kübra EMANET [1], Taner ÖZTÜRK [2]

GİRİŞ

Büyüme, bebekler ve çocuklar için nörolojik gelişimdeki ilerlemeyle eş zamanlı olarak gerçekleşen ve beklenen bir fiziksel süreçtir (1). Büyüme bir yapının farklı bölümleri arasındaki oranlarda bir değişim olmadan, boyutlarda oluşan hacimsel artış şeklinde tanımlanmaktadır (2).

Gelişim ise; büyüme sırasında yapının farklı bölümleri arasındaki birbirlerine göre oranlarının değişimi olarak tanımlanmaktadır (3).

Kraniyofasiyal büyümeyi açıklamak amacıyla Genetik, Fonksiyonel, Sentetik ve Servosistem teorileri geliştirilmiştir. Genetik teori, farklı yapıların rolünü vurgulayan üç alt başlıkta incelenir: *kemik merkezli genetik kontrol, sütur bölgelerindeki genetik etkileşimler ve kıkırdak yapıların genetik yönlendirmesi* (4). Buna karşın ilerleyen dönemde Moss (5, 6), dikkati 'fonksiyon'a yönelterek bunu, kemik-doku-boşluk etkileşiminden oluşan karmaşık bir sürecin nihai sonucu olarak açıklamıştır (Fonksiyonel teori). Sentetik teoriye göre kranium ve yüz gelişiminde belirleyici bir yapı olarak kabul edilen kondrokranyum, genetik kökenli olup özellikle orta yüz bölgesi ile kranial kubbenin morfogenezinde önemli bir rol oynamaktadır. Benzer biçimde, çevresel faktörler de bazı yapıların gelişiminde rol oynamaktadır (7). Bir diğer sentetik teori ise Servosistem Teorisi'dir. Petrovic (8), genetik ve endokrin mekanizmalarla kontrol edilen kranial taban sinkondrozisi ile septum kıkırdağının üst maksiller gelişim ve pozisyonunda önemli rol oynadığını belirtmiştir. Mandibula, oklüzal değişikliklere uyum sağlayarak periodontal ve temporomandibular eklem proprioseptörlerini aktive eder ve böylece Merkezi Sinir Sistemi'ne bilgi iletir. Bu süreç, mandibular kasların etkisiyle kondiler büyümeyi uyaran bir tepkiyi başlatır.

[1] Arş. Gör. Dt., Erciyes Üniversitesi Diş Hekimliği Fakültesi, Ortodonti AD., kubraaemanet@gmail.com, ORCID iD: 0009-0000-8792-8327

[2] Doç. Dr., Erciyes Üniversitesi Diş Hekimliği Fakültesi, Ortodonti AD., tanertr35@gmail.com, ORCID iD: 0000-0003-1670-286X

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- Pubertal büyüme atılımı kız çocuklarında erkeklere kıyasla ortalama iki yıl daha erken başlamaktadır.
- Kızlarda bu süreç genellikle 10-12 yaş aralığında başlarken, erkeklerde 12-14 yaşları arasında gözlenmektedir.

KAYNAKLAR

1. Fenton TR, Barr SM, Elmrayed S, et al. Expected and desirable preterm and small infant growth patterns. *Advances in Nutrition.* 2024;15(6):100220. doi: 10.1016/j.advnut.2024.100220
2. Erverdi N. *Çağdaş Ortodonti.* İstanbul: Quintessence Yayıncılık; 2022.
3. Ulgen M. *Ortodonti Anomaliler, Sefalometri Etioloji, Büyüme ve Gelişim, Tanı.* Ankara: 2006.
4. Castaldo G, Cerritelli F. Craniofacial growth: evolving paradigms. *Cranio: The Journal of Craniomandibular Practice.* 2015;33(1):23-31. doi: 10.1179/0886963414z.00000000042
5. Moss ML. A theoretical analysis of the functional matrix. *Acta Biotheoretica.* 1968;18(1-4):195-202. doi: 10.1007/bf01556727
6. Moss M. The primacy of functional matrices in orofacial growth. *The Dental Practitioner and Dental Record.* 1968;19:65-73.
7. Limborgh JV. A new view on the control of the morphogenesis of the skull. *Acta Morphologica Neerlando-Scandinavica.* 1970;8:143-160.
8. Petrovic A. Control of postnatal growth of secondary cartilages of the mandible by mechanisms regulating occlusion. Cybernetic model. *Transactions of the European Orthodontic Society.* 1974:69-75.
9. Opperman LA. Cranial sutures as intramembranous bone growth sites. *Developmental Dynamics: An Official Publication of the American Association of Anatomists.* 2000;219(4):472-485. doi: 10.1002/1097-0177(2000)9999:9999%3C::aid-dvdy1073%3E3.0.co;2-f
10. Roberts WE, Hartsfield JK. Bone development and function: genetic and environmental mechanisms. *Seminars in Orthodontics.* 2004;10(2):100-122: Elsevier. doi: 10.1053/j.sodo.2004.01.001
11. Sly P, Blake T, Islam Z. Impact of prenatal and early life environmental exposures on normal human development. *Paediatric Respiratory Reviews.* 2021;40:10-14. doi: 10.1016/j.prrv.2021.05.007
12. Yanjie S. Prenatal Development. *The ECPH Encyclopedia of Psychology.* Singapore: Springer; 2025. p. 1123-1125.
13. Som P, Naidich T. Illustrated review of the embryology and development of the facial region, part 1: early face and lateral nasal cavities. *American Journal of Neuroradiology.* 2013;34(12):2233-40. doi: 10.3174/ajnr.a3415
14. Ansari A, Bordoni B. *Embryology, Face*. Treasure Island (FL): StatPearls Publishing; 2024.
15. Johnson JM, Moonis G, Green GE, et al. Syndromes of the first and second branchial arches, part 1: embryology and characteristic defects. *American Journal of Neuroradiology.* 2011;32(1):14-9. doi: 10.3174/ajnr.a2072
16. Maran A, Buchanan D. Branchial cysts, sinuses and fistulae. *Clinical Otolaryngology and Allied Sciences.* 1978;3(1):77-92. doi: 10.1111/j.1365-2273.1978.tb00670.x
17. Larsen W. *Human Embryology.* United States: Elsevier/Churchill Livingstone; 2001.
18. Sadler TW. *Langman's Medical Embryology.* United States: Lippincott Williams & Wilkins; 2018.
19. Benson MT, Dalen K, Mancuso A, et al. Congenital anomalies of the branchial apparatus: embryology and pathologic anatomy. *Radiographics: a review publication of the Radiological Society of North America, Inc.* 1992;12(5):943-60. doi: 10.1148/radiographics.12.5.1529135
20. Sperber GH. Formation of the primary palate. *Cleft Lip and Palate: From Origin to Treatment.*

New York: Oxford University Press; 2002;5:13.
21. Rajion ZA, Alwi Z. Genetics of cleft lip and palate: a review. *The Malaysian Journal of Medical Sciences*. 2007;14(1):4-9.
22. Heinegård D, Saxne T. The role of the cartilage matrix in osteoarthritis. *Nature Reviews Rheumatology.* 2011;7(1):50-56. doi: 10.1038/nrrheum.2010.198
23. Hunziker EB, Lippuner K, Shintani N. How best to preserve and reveal the structural intricacies of cartilaginous tissue. *Matrix Biology: Journal of the International Society for Matrix Biology.* 2014;39:33-43. doi: 10.1016/j.matbio.2014.08.010
24. Çetinkaya E, Çetin O. Kıkırdak yapısı ve fizyolojisi. T*ürk Ortopedi ve Travmatoloji Birliği Derneği Dergisi.* 2023;22:71-74 doi: 10.5578/totbid.dergisi.2023.11
25. Pearle AD, Warren RF, Rodeo SA. Basic science of articular cartilage and osteoarthritis. *Clinics in Sports Medicine.* 2005;24(1):1-12. doi: 10.1016/j.csm.2004.08.007
26. Woods A, Wang G, Beier F. Regulation of chondrocyte differentiation by the actin cytoskeleton and adhesive interactions. J*ournal of Cellular Physiology.* 2007;213(1):1-8. doi: 10.1002/jcp.21110
27. Kini U, Nandeesh B. Physiology of bone formation, remodeling, and metabolism. *Radionuclide and Hybrid Bone Imaging.* Berlin, Heidelberg: Springer; 2012. p. 29-57.
28. İnsal B, Pişkin İ. Kemik dokusunun fizyolojisi. *Etlik Veteriner Mikrobiyoloji Dergisi.* 2017;28(1):28-32.
29. Rauch F, Schoenau E. Skeletal development in premature infants: a review of bone physiology beyond nutritional aspects. *Archives of Disease in Childhood-Fetal and Neonatal Edition.* 2002;86(2):82-85. doi: 10.1136/fn.86.2.f82
30. Soydan N. *Diş Hekimleri için Gelişim ve Büyüme.* İstanbul: Doyuran Matbaası; 1993.
31. Frandson RD, Wilke WL, Fails AD. *Anatomy and Physiology of Farm Animals.* Ames: Wiley-Blackwell; 2009.
32. Akers RM, Denbow DM. *Anatomy and physiology of domestic animals.*United States: John Wiley & Sons; 2013.
33. Mackie E, Ahmed Y, Tatarczuch L, et al. Endochondral ossification: how cartilage is converted into bone in the developing skeleton. *The International Journal of Biochemistry & Cell Biology.* 2008;40(1):46-62. doi: 10.1016/j.biocel.2007.06.009
34. Enlow DH, Bang S. Growth and remodeling of the human maxilla. *American Journal of Orthodontics.* 1965;51:446-464. doi: 10.1016/0002-9416(65)90242-3
35. Enlow DH, Moyers RE, Merow WW. *Handbook of Facial Growth.* Philadelphia: Saunders; 1982.
36. Moss ML, Salentijn L. The primary role of functional matrices in facial growth. *American Journal of Orthodontics.* 1969;55(6):566-577. doi: 10.1016/0002-9416(69)90034-7
37. Lee SK, Kim YS, Lim CY, et al. Prenatal growth pattern of the human maxilla. *Acta Anatomica.* 1992;145(1):1-10. doi: 10.1159/000147334
38. Lee SK, Kim YS, Oh HS, et al. Prenatal development of the human mandible. *The Anatomical Record.* 2001;263(3):314-25. doi: 10.1002/ar.1110
39. Moore KL, Persaud TVN, Torchia MG. *The Developing Human Clinically Oriented Embryology.* Brasil: Elsevier; 2008.
40. Alomar X, Medrano J, Cabratosa J, et al. Anatomy of the temporomandibular joint. *Seminars in Ultrasound, CT and MR;* 2007;28(3):170-183. doi: 10.1053/j.sult.2007.02.002
41. Bilgen F. Mandibulanın Prenatal ve Postnatal Gelişimi. *Turkiye Klinikleri Plastic Surgery-Special Topics.* 2018;7(3):4-7.
42. Willard VP, Arzi B, Athanasiou KA. The attachments of the temporomandibular joint disc: a biochemical and histological investigation. *Archives of Oral Biology.* 2012;57(6):599-606. doi: 10.1016/j.archoralbio.2011.10.004
43. Murray GM, Bhutada M, Peck CC, et al. The human lateral pterygoid muscle. *Archives of Oral Biology.* 2007;52(4):377-80. doi: 10.1016/j.archoralbio.2006.10.002

44. Proffit WR, Fields Jr HW, Sarver DM. *Contemporary Orthodontics.* United States: Elsevier Health Sciences; 2006.
45. Proffit WR, Fields H, Larson B, Sarver DM. *Contemporary Orthodontics-E-Book.* United States: Elsevier Health Sciences; 2018.
46. Enlow DH, Hans MG, McGrew L. Essentials of facial growth: Saunders Philadelphia; 1996.
47. Liu Y-P, Behrents RG, Buschang PH. Mandibular growth, remodeling, and maturation during infancy and early childhood. The Angle Orthodontist. 2010;80(1):97-105.
48. Proffit WR, Fields Jr HW, Sarver DM. *Contemporary Orthodontics, 5e.* India: Elsevier; 2012.
49. Gürsoy N. *Ortodontinin Biyolojik Temelleri: Kafa-Yüz-Çene Büyüme ve Gelişimi.* İstanbul Üniversitesi; 1981.
50. Yamunadevi A, Pratibha R, Rajmohan M, et al. First molars in permanent dentition and their malformations in various pathologies: a review. *Journal of Pharmacy and Bioallied Sciences.* 2021;13(1):23-30. doi: 10.4103/jpbs.jpbs_744_20
51. McDonald RE, Avery DR. *Dentistry for the Child and Adolescent.* St. Louis: Mosby; 1978.
52. Nance HN. The limitations of orthodontic treatment: I. Mixed dentition diagnosis and treatment. *American Journal of Orthodontics and Oral Surgery.* 1947;33(4):177-223. doi: 10.1016/0096-6347(47)90051-3
53. Bishara SE, Hoppens BJ, Jakobsen JR, et al. Changes in the molar relationship between the deciduous and permanent dentitions: a longitudinal study. *American Journal of Orthodontics and Dentofacial Orthopedics.* 1988;93(1):19-28. doi: 10.1016/0889-5406(88)90189-8
54. Baume LJ. Physiological tooth migration and its significance for the development of occlusion: IV. The biogenesis of overbite. *Journal of Dental Research.* 1950;29(4):440-447. doi: 10.1177/00220345500290040601
55. Sillman J. Dimensional changes of the dental arches: longitudinal study from birth to 25 years. *American Journal of Orthodontics.* 1964;50(11):824-42. doi: 10.1016/0002-9416(64)90040-5
56. Berdal A, Molla M, Hotton D, et al. Differential impact of MSX1 and MSX2 homeogenes on mouse maxillofacial skeleton. *Cells Tissues Organs.* 2008;189(1-4):126-132. doi: 10.1159/000154271
57. Zebrick B, Teeramongkolgul T, Nicot R, et al. ACTN3 R577X genotypes associate with Class II and deepbite malocclusions. *American Journal of Orthodontics and Dentofacial Orthopedics.* 2014;146(5):603-11. doi: 10.1016/j.ajodo.2014.07.021
58. Rot-Nikcevic I, Downing K, Hall B, et al. Development of the mouse mandibles and clavicles in the absence of skeletal myogenesis. *Histology and Histopathology.* 2007;22(1):51-60. doi: 10.14670/hh-22.51
59. Wolff G, Wienker T, Sander H. On the genetics of mandibular prognathism: analysis of large European noble families. *Journal of Medical Genetics.* 1993;30(2):112-116. doi: 10.1136/jmg.30.2.112
60. Cruz RM, Krieger H, Ferreira R, et al. Major gene and multifactorial inheritance of mandibular prognathism. *American Journal of Medical Genetics Part A.* 2008;146(1):71-77. doi: 10.1002/ajmg.a.32062
61. Li Q, Zhang F, Li X, et al. Genome scan for locus involved in mandibular prognathism in pedigrees from China. *Public Library of Science One.* 2010;5(9):e12678. doi: 10.1371/journal.pone.0012678
62. Oflaz MU, Görgülü S. Ortodontide Büyüme ve Gelişimin Değerlendirilmesi ve Önemi. *Ankara Diş Hekimleri Odası Klinik Bilimler Dergisi.* 2017;8(2):1571-1580.
63. Nakamoto JM. Myths and variations in normal pubertal development. *The Western Journal of Medicine.* 2000;172(3):182-185. doi: 10.1136/ewjm.172.3.182
64. Hunter CJ. The correlation of facial growth with body height and skeletal maturation at adolescence. *The Angle Orthodontist.* 1966;36(1):44-54. doi: 10.1043/0003-3219(1966)036%3C0044:tcofgw%3E2.0.co;2
65. Green LJ. The interrelationships among height, weight and chronological, dental and skeletal

ages. *The Angle Orthodontist.* 1961;31(3):189-193.
66. Hägg U, Taranger J. Skeletal stages of the hand and wrist as indicators of the pubertal growth spurt. *Acta Odontologica Scandinavica.* 1980;38(3):187-200. doi: 10.3109/00016358009004719
67. Hägg U, Matsson L. Dental maturity as an indicator of chronological age: the accuracy and precision of three methods. *European Journal of Orthodontics.* 1985;7(1):25-34. doi: 10.1093/ejo/7.1.25
68. Hägg U, Taranger J. Menarche and voice change as indicators of the pubertal growth spurt. *Acta Odontologica Scandinavica.* 1980;38(3):179-186. doi: 10.3109/00016358009004718
69. Baccetti T, Franchi L, McNamara Jr JA. An improved version of the cervical vertebral maturation (CVM) method for the assessment of mandibular growth. *The Angle Orthodontist.* 2002;72(4):316-323. doi: 10.1043/0003-3219(2002)072%3C0316:aivotc%3E2.0.co;2
70. Rosenfield RL, Cooke DW, Radovick S. Puberty and its disorders in the female. *Pediatric Endocrinology.* Elsevier Inc.; 2008. p. 530-609.
71. Breehl L, Caban O. *Physiology, Puberty.* Treasure Island (FL): StatPearls Publishing; 2018.
72. Shim KS. Pubertal growth and epiphyseal fusion. *Annals of Pediatric Endocrinology & Metabolism.* 2015;20(1):8-12. doi: 10.6065/apem.2015.20.1.8
73. Hasan S, Naseer S, Zamzam M, et al. Nutrient and hormonal effects on long bone growth in healthy and obese children: a literature review. *Children.* 2024;11(7):817. doi: 10.3390/children11070817
74. Cho JH, Jung HW, Shim KS. Growth plate closure and therapeutic interventions. *Clinical and Experimental Pediatrics.* 2024;67(11):553-559. doi: 10.3345/cep.2023.00346
75. Linder-Aronson S, Woodside D, Daigle D. A longitudinal study of the growth in length of the maxilla in boys between ages 6-20 years. *Transactions of the European Orthodontic Society.* 1975:169-179.
76. Jamison JE, Bishara SE, Peterson LC, et al. Longitudinal changes in the maxilla and the maxillary-mandibular relationship between 8 and 17 years of age. *American Journal of Orthodontics.* 1982;82(3):217-230. doi: 10.1016/0002-9416(82)90142-7
77. Jeelani W, Fida M, Shaikh A. The duration of pubertal growth peak among three skeletal classes. *Dental Press Journal of Orthodontics.* 2016;21(5):67-74. doi: 10.1590/2177-6709.21.5.067-074.oar
78. Anderson D, Thompson G, Popovich F. Interrelationships of dental maturity, skeletal maturity, height and weight from age 4 to 14 years. *Growth.* 1975;39(4):453-462.
79. Love R, Murray J, Mamandras A. Facial growth in males 16 to 20 years of age. *American Journal of Orthodontics and Dentofacial Orthopedics.* 1990;97(3):200-206. doi: 10.1016/s0889-5406(05)80052-6
80. Mitani H, Sato K, Sugawara J. Growth of mandibular prognathism after pubertal growth peak. *American Journal of Orthodontics and Dentofacial Orthopedics.* 1993;104(4):330-336. doi: 10.1016/s0889-5406(05)81329-0
81. Weaver N, Glover K, Major P, et al. Age limitation on provision of orthopedic therapy and orthognathic surgery. *American Journal of Orthodontics and Dentofacial Orthopedics.* 1998;113(2):156-164. doi: 10.1016/s0889-5406(98)70287-2
82. Inchingolo AM, Patano A, Piras F, et al. Orthognathic surgery and relapse: a systematic review. *Bioengineering.* 2023;10(9):1071. doi: 10.3390/bioengineering10091071