

Bölüm 1

ENDODONTİDE KULLANILAN GÜNCEL KÖK KANAL PATLARI

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Kök kanal patları, kanal dolumu esnasında boşlukları ve düzensizlikleri doldurarak güta perkanın kök kanal anatomisine uyumluluğunu arttıran malzemelerdir (1). Endodontik tedavinin başarısında kök kanal patları önemli bir yer teşkil etmektedir (2). Kanal tedavisi esnasında, kök kanal patı kullanılmadığı takdirde güta-perka gibi katı materyaller ile kök kanal duvarları arasında boşluklar kalmaktadır, bu da yetersiz kanal tedavisine neden olmaktadır (3).

Kök kanal dolgu patlarının kullanım amaçları şu şekilde sıralanmaktadır (1):

1. Kök kanal dolgu maddesinin kanal duvarlarına adapte olmasını sağlamak ve dolgu maddesi ile dentin duvarları arasındaki boşluğu örtmek.
2. Kayganlaştırıcı etki oluşturarak kök kanal dolgusunu kolaylaştırmak.
3. İçeriğindeki antibakteriyel maddeler sayesinde, kök kanalına yerleştirildikten sonra antibakteriyel özellik gösterirler.

Grossman'a göre ideal bir kök kanal patında bulunması gereken özellikler şu şekildedir (1):

1. Sertleştiği zaman kanal duvarlarına iyi bir adezyon sağlamalıdır.
2. Hermetik bir örtüleme sağlamalıdır.
3. Radyografide görüntülenebilmesi için radyoopak olmalıdır.

Toz kısmı, likit kısmı ile kolayca karışabilmesi için ince partüküler yapıda olmalıdır.

4. Sertleşme esnasında büzüşme eğiliminde olmamalıdır.
5. Diş yapısında renklenmeye sebep olmamalıdır.
6. Bakteriyostatik olmalı veya en azından bakteri üremesini önlemelidir.
7. Yavaş sertleşmelidir.
8. Doku sıvılarında çözünmemelidir.
9. Doku dostu olmalı ve periradiküler dokuları irrite etmemelidir.

10. Kök kanalından sökülmesi gerektiğinde çözücüler ile çözünebilir olmalıdır.

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Partikül-biyomolekül etkileşimleri sırasında çeşitli faktörlerin etkisi göz önünde bulundurulmalıdır. Ayrıca, literatürde iyi tasarlanmış uzun vadeli sonuçların gösterildiği klinik çalışmaların eksikliği de duyulmaktadır.

SONUÇ

İdeal kanal patı kriterlerinin tamamını karşılayan bir kanal dolgu patı bulunmamakla beraber, bugüne kadar mevcut olan in vitro ve in vivo verilere dayanarak ideale en yakın kanal dolgu patının biyoseramikler olduğu söylenebilir. Ancak unutulmamalıdır ki; hangi pat kullanılırsa kullanılsın, tüm patlar sertleşene kadar toksik etkiye sahip olması nedeniyle, kanal dolum aşamasında periradiküler dokulara taşımaktan kaçınılmalıdır.

KAYNAKÇA

1. Johnson WT, Kulild JC. Obturation of the Cleaned and Shaped Root Canal System. In: Hargreaves KÖ, Cohen S. (eds) *Cohen's Pathways of the Pulp*. Tenth Edition. China: Mosby Elseiver; 2011. p.349–388.
2. Waltimo TMT, Boiesen J, Eriksen HM, et al. Clinical performance of 3 endodontic sealers. *Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics*. 2001;92(1):89–92. doi: 10.1067/moe.2001.116154.
3. Lee KW, Williams MC, Camps JJ, et al. Adhesion of endodontic sealers to dentin and gutta-percha. *Journal of endodontics*. 2002;28(10):684–8. doi: 10.1097/00004770-200210000-00002.
4. Guigand M, Pellen-Mussi P, Le Goff A, et al. Evaluation of the cytocompatibility of three endodontic materials. *Journal of endodontics*. 1999;25(6):419–23. doi: 10.1016/s0099-2399(99)80270-2
5. Kelmendi T, Koçani F, Kurti A, et al. Comparison of Sealing Abilities Among Zinc Oxide Eugenol Root-Canal Filling Cement, Antibacterial Bioceramic Paste, and Epoxy Resin, using *Enterococcus faecalis* as a Microbial Tracer. *Medical science monitor basic research*. 2022;28:e936319. doi: 10.12659/MSMBR.936319.
6. Gaeta C, Marruganti C, Mignosa E, et al. Comparison of physico-chemical properties of zinc oxide eugenol cement and a bioceramic sealer. *Australian endodontic journal*. 2022 doi: 10.1111/aej.12715
7. Hauman CHJ, Love RM. Biocompatibility of dental materials used in contemporary endodontic therapy: A review. Part 1. Intracanal drugs and substances. *International Endodontic Journal*. 2003;36(2):75–85. doi: 10.1046/j.1365-2591.2003.00631.x.
8. Leonardo MR, Leal JM, Filho APS. Pulpectomy: immediate root canal filling with calcium hydroxide. Concept and procedures. *Oral surgery, oral medicine, and oral pathology* . 1980;49(5):441–50. doi: 10.1016/0030-4220(80)90289-3.
9. Goldberg F, Gurfinkel J. Analysis of the use of Dycal with gutta-percha points as an endodontic filling technique. *Oral surgery, oral medicine, and oral pathology* 1979;47(1):78–82. doi: 10.1016/0030-4220(79)90106-3.
10. Gencoglu N. Kök kanalı dolgu materyalleri. In:Kaan Asci S. *Endodonti, 1.baskı* ;İstanbul: Quintessence; 2014. p.461-471.

11. Tagger M, Tagger E, Kfir A. Release of calcium and hydroxyl ions from set endodontic sealers containing calcium hydroxide. *Journal of endodontics*. 1988;14(12):588-91. doi: 10.1016/S0099-2399(88)80055-4.
12. Wu MK, Wesselink PR, Boersma J. A 1-year follow-up study on leakage of four root canal sealers at different thicknesses. *International endodontic journal* 1995;28(4):185-9.
13. Wennber A, Niom Do. Adhesion of root canal sealers to bovine dentine and gutta-percha. *International endodontic journal*. 1990;23(1):13-9. doi: 10.1111/j.1365-2591.1990.tb00797.x.
14. Kocll K, Min PS, Stewart GG. Comparison of apical leakage between Ketac Endo sealer and Grossman sealer. *Oral surgery, oral medicine, and oral pathology*. 1994;78(6):784-7. doi: 10.1016/0030-4220(94)90096-5.
15. Mount GJ. Glass ionomers: a review of their current status. *Oper Dent*. 1999;24(2):115-124.
16. De Bruyne MAA, De Moor RJG. The use of glass ionomer cements in both conventional and surgical endodontics. *International endodontic journal*. 2004;37(2):91-104. doi: 10.1111/j.0143-2885.2004.00769.x.
17. Çalışkan K. *Endodontide Tanı ve Tedaviler*. 2.baskı; İstanbul: Nobel Tıp Kitapevi; 2014. p.401-432
18. Carvalho-Júnior JR, Guimarães LFL, Correr-Sobrinho L, et al. Evaluation of solubility, disintegration, and dimensional alterations of a glass ionomer root canal sealer. *Brazilian dental journal*. 2003;14(2):114-8. doi: 10.1590/s0103-64402003000200008.
19. Kontakiotis EG, Wu MK, Wesselink PR. Effect of sealer thickness on long-term sealing ability: a 2-year follow-up study. *International endodontic journal*. 1997;30(5):307-12. doi: 10.1046/j.1365-2591.1997.00087.x.
20. Mohammadi Z, Yazdizadeh M, Shalavi S. Non-surgical repair of internal resorption with MTA: A case report. *Iranian Endodontic Journal*. 2012;7(4):211-214.
21. Spångberg LSW, Barbosa S V., Lavigne GD. AH 26 releases formaldehyde. *Journal of endodontics* . 1993;19(12):596-8. doi: 10.1016/S0099-2399(06)80272-4.
22. Castelluci A. Obturation of the radiular spaces. In: Rotstein I, Ingle J. *Ingle's Endodontics* 7, 50th edition; USA: Nobel Tıp Kitapevi;2006 . p.669-728.
23. Leonardo MR, Silva LAB Da, Filho MT, et al. Release of formaldehyde by 4 endodontic sealers. *Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics*. 1999;88(2):221-5. doi: 10.1016/s1079-2104(99)70119-8.
24. Huang FM, Tai KW, Chou MY, et al. Cytotoxicity of resin-, zinc oxide-eugenol-, and calcium hydroxide-based root canal sealers on human periodontal ligament cells and permanent V79 cells. *International endodontic journal*. 2002 Feb;35(2):153-8. doi:10.1046/j.1365-2591.2002.00459.x
25. Ørstavik D. Materials used for root canal obturation: technical, biological and clinical testing. *Endodontic Topics*. 2005;12(1):25-38.
26. Saleh IM, Ruyter IE, Haapasalo M, et al. Survival of *Enterococcus faecalis* in infected dentinal tubules after root canal filling with different root canal sealers in vitro. *International endodontic journal*. 2004;37(3):193-198. doi: 10.1111/j.0143-2885.2004.00785.x.
27. Özok AR, van der Sluis LWM, Wu MK, et al. Sealing ability of a new polydimethylsiloxane-based root canal filling material. *Journal of endodontics* 2008;34(2):204-7. doi:10.1016/j.joen.2007.11.005

28. Kim YK, Grandini S, Ames JM, et al. Critical review on methacrylate resin-based root canal sealers. *Journal of endodontics*. 2010;36(3):383–399. doi: 10.1016/j.joen.2009.10.023.
29. Shanahan DJ, Duncan HF. Root canal filling using Resilon: a review. *British dental journal*. 2011;211(2):81–8. doi:10.1038/sj.bdj.2011.573
30. De-Deus G, Namen F, Galan J. Reduced long-term sealing ability of adhesive root fillings after water-storage stress. *Journal of endodontics*. 2008 16];34(3):322–5. doi:10.1016/j.joen.2007.12.014
31. Sevimay S, Kalayci A. Evaluation of apical sealing ability and adaptation to dentine of two resin-based sealers. *Journal of oral rehabilitation*. 2005;32(2):105–10. doi: 10.1111/j.1365-2842.2004.01385.x
32. Shen Y, Peng B, Yang Y, et al. What do different tests tell about the mechanical and biological properties of bioceramic materials? *Endodontic Topics* [Internet]. 2015;32(1):47–85.
33. Iftikhar S, Jahanzeb N, Saleem M, et al. The trends of dental biomaterials research and future directions: A mapping review. *The Saudi dental journal*. 2021;33(5):229–38. doi: 10.1016/j.sdentj.2021.01.002.
34. Jitaru S, Hodisan I, Timis L, Lucian A, Bud M. The use of bioceramics in endodontics - literature review. *Clujul Med*. 2016;89(4):470-473. doi:10.15386/cjmed-612
35. Shinbori N, Grama AM, Patel Y, et al. Clinical outcome of endodontic microsurgery that uses EndoSequence BC root repair material as the root-end filling material. *J Endod*. 2015;41(5):607-612. doi:10.1016/j.joen.2014.12.028
36. Al-Haddad A, Che Ab Aziz ZA. Bioceramic-Based Root Canal Sealers: A Review. *Int J Biomater*. 2016;2016:9753210. doi:10.1155/2016/9753210.
37. Tarhan SÇ, Uzunoglu E. Kök Kanal Dolgu Maddeleri. *Türkiye Klinikleri Journal of Dental Sciences Special Topics*. 2010;1(3):1–15.
38. Amoroso-Silva PA, Guimarães BM, Marciano MA, et al. Microscopic analysis of the quality of obturation and physical properties of MTA Fillapex. *Microsc Res Tech*. 2014;77(12):1031-1036. doi:10.1002/jemt.22432
39. Viapiana R, Guerreiro-Tanomaru JM, Hungaro-Duarte MA, et al. Chemical characterization and bioactivity of epoxy resin and Portland cement-based sealers with niobium and zirconium oxide radiopacifiers. *Dent Mater*. 2014;30(9):1005-1020. doi:10.1016/j.dental.2014.05.007
40. Salem Milani A, Radmand F, Rahbani B, et al. Effect of Different Mixing Methods on Physicochemical Properties of Mineral Trioxide Aggregate: A Systematic Review. *Int J Dent*. 2023;2023:5226095. Published 2023 Feb 16. doi:10.1155/2023/5226095
41. Cervino G, Laino L, D'Amico C, et al. Mineral Trioxide Aggregate Applications in Endodontics: A Review. *Eur J Dent*. 2020;14(4):683-691. doi:10.1055/s-0040-1713073
42. Tani-Ishii N, Mutoh N, Muromachi K, et al. The clinical evaluation of vertical root fracture after endodontic treatment with mineral trioxide aggregate. *Integrative molecular medicine*. 2017;4(3):1-5 doi: 10.15761/IMM.1000288
43. Dawood AE, Parashos P, Wong RHK, et al. Calcium silicate-based cements: composition, properties, and clinical applications. *J Investig Clin Dent*. 2017;8(2):10.1111/jicd.12195. doi:10.1111/jicd.12195
44. Parirokh M, Torabinejad M, Dummer PMH. Mineral trioxide aggregate and other bioactive endodontic cements: an updated overview - part I: vital pulp therapy. *Int Endod J*. 2018;51(2):177-205. doi:10.1111/iej.12841

45. Eskandari F, Razavian A, Hamidi R, et al. An Updated Review on Properties and Indications of Calcium Silicate-Based Cements in Endodontic Therapy. *Int J Dent.* 2022;2022:6858088. doi:10.1155/2022/6858088
46. Jafari F, Jafari S. Composition and physicochemical properties of calcium silicate based sealers: A review article. *J Clin Exp Dent.* 2017;9(10):e1249-e1255. doi:10.4317/jced.54103
47. Song W, Li S, Tang Q, Chen L, Yuan Z. *In vitro* biocompatibility and bioactivity of calcium silicatebased bioceramics in endodontics (Review). *Int J Mol Med.* 2021;48(1):128. doi:10.3892/ijmm.2021.4961
48. Chang SW, Lee SY, Kang SK, et al. In vitro biocompatibility, inflammatory response, and osteogenic potential of 4 root canal sealers: Sealapex, Sankin apatite root sealer, MTA Fillapex, and iRoot SP root canal sealer. *J Endod.* 2014;40(10):1642-1648. doi:10.1016/j.joen.2014.04.006
49. Giacomino CM, Wealleans JA, Kuhn N, Diogenes A. Comparative Biocompatibility and Osteogenic Potential of Two Bioceramic Sealers. *J Endod.* 2019;45(1):51-56. doi:10.1016/j.joen.2018.08.007
50. Ruiz-Linares M, de Oliveira Fagundes J, Solana C, et al. Current status on antimicrobial activity of a tricalcium silicate cement. *J Oral Sci.* 2022;64(2):113-117. doi:10.2334/josnusd.21-0439
51. Esteki P, Jahromi MZ, Tahmourespour A. *In vitro* antimicrobial activity of mineral trioxide aggregate, Biodentine, and calcium-enriched mixture cement against *Enterococcus faecalis*, *Streptococcus mutans*, and *Candida albicans* using the agar diffusion technique. *Dent Res J (Isfahan).* 2021;18:3.
52. Ashkar I, Sanz JL, Forner L, et al. Calcium Silicate-Based Sealer Dentinal Tubule Penetration-A Systematic Review of In Vitro Studies. *Materials (Basel).* 2023;16(7):2734. doi:10.3390/ma16072734
53. Abdulsamad Alskaf MK, Achour H, Alzoubi H. The Effect of Bioceramic HiFlow and EndoSequence Bioceramic Sealers on Increasing the Fracture Resistance of Endodontically Treated Teeth: An In Vitro Study. *Cureus.* 2022;14(12):e33051. doi:10.7759/cureus.33051
54. Merçon IR, da Silveira Bueno CE, Rocha DGP, Fontana CE, Pais ASG, De Martin AS. Root Fracture Resistance of Maxillary Premolars Obturated with Three Root Canal Sealers after Passive Ultrasonic Irrigation: An *in Vitro* study. *Iran Endod J.* 2020;15(3):166-172. doi:10.22037/iej.v15i3.26426
55. Coaguila-Llerena H, Gaeta E, Faria G. Outcomes of the GentleWave system on root canal treatment: a narrative review. *Restor Dent Endod.* 2022;47(1):e11. doi:10.5395/rde.2022.47.e11
56. Santos-Junior AO, Tanomaru-Filho M, Pinto JC, Tavares KIMC, Torres FFE, Guerreiro-Tanomaru JM. Effect of obturation technique using a new bioceramic sealer on the presence of voids in flattened root canals. *Braz Oral Res.* 2021;35:e028. doi:10.1590/1807-3107bor-2021.vol35.0028
57. Girelli CF, Lacerda MF, Lemos CA, et al. The thermoplastic techniques or single-cone technique on the quality of root canal filling with tricalcium silicate-based sealer: An integrative review. *J Clin Exp Dent.* 2022;14(7):e566-e572. doi:10.4317/jced.59387
58. Heran J, Khalid S, Albaaj F, et al. The single cone obturation technique with a modified warm filler. *J Dent.* 2019;89:103181. doi:10.1016/j.jdent.2019.103181

59. ISO 6876:2001 - Dental root canal sealing materials. (Online) Available from: <https://www.iso.org/standard/34965.html> (Accessed 16th Jul 2023).
60. Candeiro GT, Correia FC, Duarte MA, Ribeiro-Siqueira DC, Gavini G. Evaluation of radiopacity, pH, release of calcium ions, and flow of a bioceramic root canal sealer. *J Endod.* 2012;38(6):842-845. doi:10.1016/j.joen.2012.02.029
61. Mekhdieva E, Del Fabbro M, Alovisei M, et al. Postoperative Pain following Root Canal Filling with Bioceramic vs. Traditional Filling Techniques: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *J Clin Med.* 2021;10(19):4509. doi:10.3390/jcm10194509
62. Aslan T, Dönmez Özkan H. The effect of two calcium silicate-based and one epoxy resin-based root canal sealer on postoperative pain: a randomized controlled trial. *Int Endod J.* 2021;54(2):190-197. doi:10.1111/iej.13411
63. Chybowski EA, Glickman GN, Patel Y, et al. Clinical Outcome of Non-Surgical Root Canal Treatment Using a Single-cone Technique with Endosequence Bioceramic Sealer: A Retrospective Analysis. *J Endod.* 2018;44(6):941-945. doi:10.1016/j.joen.2018.02.019
64. AlBakhakh B, Al-Saedi A, Al-Tae R, et al. Rapid Apical Healing with Simple Obturation Technique in Response to a Calcium Silicate-Based Filling Material. *Int J Dent.* 2022;2022:6958135. doi:10.1155/2022/6958135
65. Zavattini A, Knight A, Foschi F, et al. Outcome of Root Canal Treatments Using a New Calcium Silicate Root Canal Sealer: A Non-Randomized Clinical Trial. *J Clin Med.* 2020;9(3):782. doi:10.3390/jcm9030782
66. Bardini G, Casula L, Ambu E, et al. A 12-month follow-up of primary and secondary root canal treatment in teeth obturated with a hydraulic sealer. *Clin Oral Investig.* 2021;25(5):2757-2764. doi:10.1007/s00784-020-03590-0
67. Song M, Park MG, Kwak SW, et al. Pilot Evaluation of Sealer-Based Root Canal Obturation Using Epoxy-Resin-Based and Calcium-Silicate-Based Sealers: A Randomized Clinical Trial. *Materials (Basel).* 2022;15(15):5146. doi:10.3390/ma15155146
68. Mattison GD, von Fraunhofer JA. Electrochemical microleakage study of endodontic sealer/cements. *Oral Surg Oral Med Oral Pathol.* 1983;55(4):402-407. doi:10.1016/0030-4220(83)90195-0
69. Von Fraunhofer JA, Branstetter J. The physical properties of four endodontic sealer cements. *J Endod.* 1982;8(3):126-130. doi:10.1016/S0099-2399(82)80248-3
70. Fonseca DA, Paula AB, Marto CM, et al. Biocompatibility of Root Canal Sealers: A Systematic Review of In Vitro and In Vivo Studies. *Materials (Basel).* 2019;12(24):4113. doi:10.3390/ma12244113
71. Komabayashi T, Colmenar D, Cvach N, et al. Comprehensive review of current endodontic sealers. *Dent Mater J.* 2020;39(5):703-720. doi:10.4012/dmj.2019-288
72. Pelliccioni GA, Vellani CP, Gatto MR, et al. Proroot mineral trioxide aggregate cement used as a retrograde filling without addition of water: an in vitro evaluation of its microleakage. *J Endod.* 2007;33(9):1082-1085. doi:10.1016/j.joen.2007.04.009
73. Benetti F, de Azevedo Queiroz ÍO, Oliveira PHC, et al. Cytotoxicity and biocompatibility of a new bioceramic endodontic sealer containing calcium hydroxide. *Braz Oral Res.* 2019;33:e042. doi:10.1590/1807-3107bor-2019.vol33.0042
74. Gaudin A, Tolar M, Peters OA. Cytokine Production and Cytotoxicity of Calcium Silicate-based Sealers in 2- and 3-dimensional Cell Culture Models. *J Endod.* 2020;46(6):818-826. doi:10.1016/j.joen.2020.03.011

75. Alsubait SA, Al Ajlan R, Mitwalli H, et al. Cytotoxicity of Different Concentrations of Three Root Canal Sealers on Human Mesenchymal Stem Cells. *Biomolecules*. 2018;8(3):68. doi:10.3390/biom8030068
76. Lee JK, Kim S, Lee S. In Vitro Comparison of Biocompatibility of Calcium Silicate-Based Root Canal Sealers. *Materials (Basel)*. 2019;12(15):2411. doi:10.3390/ma12152411
77. Seo DG, Lee D, Kim YM, et al. Biocompatibility and Mineralization Activity of Three Calcium Silicate-Based Root Canal Sealers Compared to Conventional Resin-Based Sealer in Human Dental Pulp Stem Cells. *Materials (Basel)*. 2019;12(15):2482. doi:10.3390/ma12152482
78. Saghiri MA, Karamifar K, Nath D, et al. A Novel Polyurethane Expandable Root Canal Sealer. *J Endod*. 2021;47(4):612-620. doi:10.1016/j.joen.2020.12.007
79. Jo SB, Kim HK, Lee HN, et al. Physical Properties and Biofunctionalities of Bioactive Root Canal Sealers In Vitro. *Nanomaterials (Basel)*. 2020;10(9):1750. doi:10.3390/nano10091750
80. Silva Almeida LH, Moraes RR, et al. Are Premixed Calcium Silicate-based Endodontic Sealers Comparable to Conventional Materials? A Systematic Review of In Vitro Studies. *J Endod*. 2017;43(4):527-535. doi:10.1016/j.joen.2016.11.019
81. Chen B, Haapasalo M, Mobuchon C, et al. Cytotoxicity and the Effect of Temperature on Physical Properties and Chemical Composition of a New Calcium Silicate-based Root Canal Sealer. *J Endod*. 2020;46(4):531-538. doi:10.1016/j.joen.2019.12.009
82. Rossato TCA, Gallas JA, da Rosa WLO, et al. Experimental Sealers Containing Metal Methacrylates: Physical and Biological Properties. *J Endod*. 2017;43(10):1725-1729. doi:10.1016/j.joen.2017.05.018