BÖLÜM 8

İMMATÜR DİŞLERDE REJENERATİF ENDODONTİ UYGULAMALARI

İrem ÇETİNKAYA [1]

GİRİŞ

Çocukluk döneminde diş ve destek dokuları travma ve çürükten çokça etkilenmektedir. Özellikle kök gelişimini tamamlamamış 7-10 yaş grubu sıklıkla travmalara maruz kalmakta ve endodontik tedavi ihtiyacı doğmaktadır. Dentin çürüğü ile bakteri toksinleri dentin tübülleri boyunca ilerleyip pulpa dokularında kronik enflamatuar reaksiyon oluşmasına neden olabilmektedir (Ford 2004). Pulpa şiddetli bir irritanla karşılaştığında enflamasyon başlamakta ve pulpa dokusuna ulaşan bakteriler pulpa dokusunun nekrozuna ve periapikal enfeksiyonlara yol açmaktadır (Ford 2004; Nakashima and Akamine 2005). Dişler üzerine gelen travmatik kuvvetler, dişlerde farklı büyüklüklerde zarara ve morfolojik bütünlüklerinde bozulmalara neden olabilmektedir (Svensäter, Chávez de Paz, and Theilade 2010). Travma sonucunda pulpa dokusunun oral kaviteye açılması nedeniyle ağız içerisinde bulunan mikroorganizmalar pulpa dokusuna ulaşarak enfeksiyon oluşturabilmekle (Nakashima and Akamine 2005) birlikte, şiddetli travma nedeniyle dişin apeksinde bulunan damar-sinir paketinin zedelenmesiyle pulpa dokusunda nekroz oluşumu meydana gelebilmektedir (Pitt-Ford 2008). Oluşan bu nekrozun sonunda gelişimini tamamlamamış dişlerin kök gelişimi durmakta ve kök ucu gütaperka ile hermetik tıkacın sağlanamayacağı kadar açık kalmaktadır. Bu sebeple immatür nekrotik daimi dişlere apikalde sert doku oluşturarak kapanmanın sağlandığı tedavi yöntemi olan "apeksifikasyon" yapılabilmektedir (Fuks 2000). Apeksifikasyon tedavisinde kalsiyum hidroksitle apeksifikasyon, MTA ile apikal tıkaç oluşturularak yapılan apeksifikasyon ve rejeneratif endodontik tedavi gibi birçok yöntem uygulanmaktadır (Iwaya, Ikawa, and Kubota 2001). Nekrotik pulpalı immatür daimi dişlerde sıklıkla kalsiyum hidroksitle sert doku bariyeri oluşturarak (apeksifikasyon) ya da kök kanal tedavisi öncesinde MTA tıkaç oluşturularak tedavi

[1] Dr. Öğr. Üyesi, Trakya Üniversitesi Diş Hekimliği Fakültesi, Endodonti AD. irem.cetinkaya@trakya.edu.tr

ucu kapanmış dişlerde de tedavinin prognozunu arttırmak için tercih edilmeye başlanmıştır.

KAYNAKLAR

Al-Hezaimi, Khalid, Badr Abdullah Al-Tayar, Yaseer Salim BaJuaifer, Ziad Salameh, Khalid Al-Fouzan, and Franklin R %J Journal of endodontics Tay. 2011. 'A hybrid approach to direct pulp capping by using emdogain with a capping material', 37: 667-72.

Ando, Yusuke, Masaki J Honda, Hayato Ohshima, Akiko Tonomura, Takayuki Ohara, Toshimitsu Itaya, Hideaki Kagami, and Minoru %J Nagoya J Med Sci Ueda. 2009. 'The induction of dentin bridge-like structures by constructs of subcultured dental pulp-derived cells and porous HA/TCP in porcine teeth', 71: 51-62.

Andreasen, Jens Ove, Ban Farik, and Erik Christian %J Dental Traumatology Munksgaard. 2002. 'Long-term calcium hydroxide as a root canal dressing may increase risk of root fracture', 18: 134-37.

Andreasen, JO, Mette Kit Borum, Henrik Loft Jacobsen, and Frances M %J Dental Traumatology Andreasen. 1995. 'Replantation of 400 avulsed permanent incisors. 2. Factors related to pulpal healing', 11: 59-68.

Anitua, Eduardo, Isabel Andia, Bruno Ardanza, Paquita Nurden, Alan T %J Thrombosis Nurden, and haemostasis. 2004. 'Autologous platelets as a source of proteins for healing and tissue regeneration', 91: 4-15.

Banchs, Francisco, and Martin %J Journal of endodontics Trope. 2004. 'Revascularization of immature permanent teeth with apical periodontitis: new treatment protocol?', 30: 196-200.

Bègue-Kirn, CATHERINE, ANTHONY J Smith, MARIA Loriot, CHRISTIAN Kupferle, JV Ruch, and H %J The International journal of developmental biology Lesot. 1994. 'Comparative analysis of TGF beta s, BMPs, IGF1, msxs, fibronectin, osteonectin and bone sialoprotein gene expression during normal and in vitro-induced odontoblast differentiation', 38: 405-20.

Berman, Louis H, and Kenneth M Hargreaves. 2015. *Cohen's Pathways of the Pulp Expert Consult-E-Book* (Elsevier Health Sciences).

Bidder, Miri, Tammy Latifi, Dwight A %J Journal of Bone Towler, and Mineral Research. 1998. 'Reciprocal temporospatial patterns of Msx2 and Osteocalcin gene expression during murine odontogenesis', 13: 609-19.

Blin-Wakkach, C, F Lezot, S Ghoul-Mazgar, D Hotton, S Monteiro, C Teillaud, L Pibouin, S Orestes-Cardoso, P Papagerakis, and M %J Proceedings of the National Academy of Sciences Macdougall. 2001. 'Endogenous Msx1 antisense transcript: in vivo and in vitro evidences, structure, and potential involvement in skeleton development in mammals', 98: 7336-41.

Coudert, Amelie E, Laurence Pibouin, Brigitte Vi-Fane, Bethan L Thomas, Mary Macdougall, Anuradha Choudhury, Benoît Robert, Paul T Sharpe, Ariane Berdal, and Frédéric %J Nucleic acids research Lezot. 2005. 'Expression and regulation of the Msx1 natural antisense transcript during development', 33: 5208-18.

Cvek, Miomir %J Dental Traumatology. 1992. 'Prognosis of luxated non-vital maxillary incisors treated with calcium hydroxide and filled with gutta-percha. A retrospective clinical study', 8: 45-55.

de Paz, Luis E Chávez, Gunnar Bergenholtz, and Gunnel %J Journal of Endodontics Svensäter. 2010. 'The effects of antimicrobials on endodontic biofilm bacteria', 36: 70-77.

De Rossi, Andiara, Lea Assed Bezerra Silva, Patrícia Gatón-Hernández, Manoel Damião Sousa-Neto, Paulo Nelson-Filho, Raquel Assed Bezerra Silva, and Alexandra Mussolino %J Journal of endodontics de Queiroz. 2014. 'Comparison of pulpal responses to pulpotomy and pulp capping with biodentine and mineral trioxide aggregate in dogs', 40: 1362-69.

Demarco, Flavio F, Luciano Casagrande, Zhaocheng Zhang, Zhihong Dong, Sandra B Tarquinio, Benjamin D Zeitlin, Songtao Shi, Anthony J Smith, and Jacques E %J Journal of endodontics

Nör. 2010. 'Effects of morphogen and scaffold porogen on the differentiation of dental pulp stem cells', 36: 1805-11.

Diogenes, Anibal, Michael A Henry, Fabricio B Teixeira, and Kenneth M %J Endodontic Topics Hargreaves. 2013. 'An update on clinical regenerative endodontics', 28: 2-23.

Duque, Jussaro Alves, Clovis Monteiro Bramante, Marco Antonio Hungaro Duarte, Murilo Priori Alcalde, Emmanuel João Nogueira Leal Silva, and Rodrigo Ricci %J Journal of Endodontics Vivan. 2020. 'Cyclic Fatigue Resistance of Nickel-Titanium Reciprocating Instruments after Simulated Clinical Use'.

Durand, Stéphanie H, Vincent Flacher, Annick Roméas, Florence Carrouel, Evelyne Colomb, Claude Vincent, Henry Magloire, Marie-Lise Couble, Françoise Bleicher, and Marie-Jeanne %J The Journal of Immunology Staquet. 2006. ‹Lipoteichoic acid increases TLR and functional chemokine expression while reducing dentin formation in in vitro differentiated human odontoblasts', 176: 2880-87.

El-Backly, Rania M, Ahmed G Massoud, Azza M El-Badry, Raef A Sherif, and Mona K %J Australian Endodontic Journal Marei. 2008. 'Regeneration of dentine/pulp-like tissue using a dental pulp stem cell/poly (lactic-co-glycolic) acid scaffold construct in New Zealand white rabbits', 34: 52-67.

Endodontists, American Association of. 2021. "Clinical considerations for a regenerative procedure." In.: American Association of Endodontists Chicago.

Fang, Yanjun, Xinhuan Wang, Jingjing Zhu, Chaonan Su, Ying Yang, and Liuyan %J Journal of endodontics Meng. 2018. 'Influence of apical diameter on the outcome of regenerative endodontic treatment in teeth with pulp necrosis: a review', 44: 414-31.

Fanton d'Andon, Martine, Nathalie Quellard, Béatrice Fernandez, Gwenn Ratet, Sonia Lacroix-Lamandé, Alain Vandewalle, Ivo G Boneca, Jean-Michel Goujon, and Catherine %J PLoS neglected tropical diseases Werts. 2014. 'Leptospira Interrogans induces fibrosis in the mouse kidney through Inos-dependent, TLR-and NLR-independent signaling pathways', 8: e2664.

Fitzgerald, M, DJ Chiego Jr, and DR %J Archives of oral biology Heys. 1990. 'Autoradiographic analysis of odontoblast replacement following pulp exposure in primate teeth', 35: 707-15.

Ford, TR Pitt. 2004. "Pickard's Manual of Operative Dentistry 8th edition (2003)." In.: Oxford University Press.

Fuks, Anna B %J Dental Clinics of North America. 2000. 'Pulp therapy for the primary and young permanent dentitions', 44: 571-96, vii.

Galler, Kerstin M, RN D'souza, JD Hartgerink, and G %J Advances in Dental Research Schmalz. 2011. 'Scaffolds for dental pulp tissue engineering', 23: 333-39.

Galler, KM, G Krastl, S Simon, G Van Gorp, Nastaran Meschi, B Vahedi, and Paul %J International endodontic journal Lambrechts. 2016. 'European Society of Endodontology position statement: revitalization procedures', 49: 717-23.

Haapasalo, Markus, and YA %J Endodontic Topics Shen. 2010. 'Current therapeutic options for endodontic biofilms', 22: 79-98.

Hargreaves, Kenneth M, Todd Giesler, Michael Henry, and Yan %J Pediatric dentistry Wang. 2008. 'Regeneration potential of the young permanent tooth: what does the future hold?', 30: 253-60.

Huang, Fu-Mei, Shun-Fa Yang, Jiing-Huei Zhao, and Yu-Chao %J Journal of endodontics Chang. 2010. 'Platelet-rich fibrin increases proliferation and differentiation of human dental pulp cells', 36: 1628-32.

Huang, George T-J, and Louis M %J Journal of endodontics Lin. 2008. 'Letter to the editor: Comments on the use of the term "revascularization" to describe', 34: 511.

Huang, GT-J %J International endodontic journal. 2009. 'Apexification: the beginning of its end', 42: 855-66.

Iohara, Koichiro, Kiyomi Imabayashi, Ryo Ishizaka, Atsushi Watanabe, Junichi Nabekura, Masataka Ito, Kenji Matsushita, Hiroshi Nakamura, and Misako %J Tissue Engineering Part A Nakashima. 2011. 'Complete pulp regeneration after pulpectomy by transplantation of CD105+ stem cells with stromal cell-derived factor-1', 17: 1911-20.

Ito, Kenji, Yoichi Yamada, Tetsuro Nagasaka, Shunsuke Baba, Minoru %J Journal of Biomedical Materials Research Part A: An Official Journal of The Society for Biomaterials Ueda, The Japanese Society for Biomaterials,, The Australian Society for Biomaterials, and the Korean Society for Biomaterials. 2005. 'Osteogenic potential of injectable tissue-engineered bone: a comparison among autogenous bone, bone substitute (Bio-Oss®), platelet-rich plasma, and tissue-engineered bone with respect to their mechanical properties and histological findings', 73: 63-72.

Iwaya, Shin-ichi, Motohide Ikawa, and Minoru %J Dental Traumatology Kubota. 2001. 'Revascularization of an immature permanent tooth with apical periodontitis and sinus tract', 17: 185-87.

Kellner, Manuela, Marina M Steindorff, Jürgen F Strempel, Andreas Winkel, Mark P Kühnel, and Meike %J Archives of Oral Biology Stiesch. 2014. ‹Differences of isolated dental stem cells dependent on donor age and consequences for autologous tooth replacement', 59: 559-67.

Kim, SG, M Malek, A Sigurdsson, LM Lin, and B %J International endodontic journal Kahler. 2018. 'Regenerative endodontics: a comprehensive review', 51: 1367-88.

Kitikuson, Pattama, and Tanida %J Journal of endodontics Srisuwan. 2016. 'Attachment ability of human apical papilla cells to root dentin surfaces treated with either 3Mix or calcium hydroxide', 42: 89-94.

Kontakiotis, Evangelos G, Christos G Filippatos, Giorgos N Tzanetakis, and Anastasia %J Journal of endodontics Agrafioti. 2015. 'Regenerative endodontic therapy: a data analysis of clinical protocols', 41: 146-54.

Lauridsen, Eva, Nuno Vibe Hermann, Thomas Alexander Gerds, Søren Steno Ahrensburg, Sven Kreiborg, and Jens Ove %J Dental Traumatology Andreasen. 2012. 'Combination injuries 3. The risk of pulp necrosis in permanent teeth with extrusion or lateral luxation and concomitant crown fractures without pulp exposure', 28: 379-85.

Li, Z, C-M Jiang, S An, Q Cheng, Y-F Huang, Y-T Wang, Y-C Gou, L Xiao, W-J Yu, and J %J Oral diseases Wang. 2014. 'Immunomodulatory properties of dental tissue-derived mesenchymal stem cells', 20: 25-34.

Lovelace, Tyler W, Michael A Henry, Kenneth M Hargreaves, and Anibal %J Journal of endodontics Diogenes. 2011. 'Evaluation of the delivery of mesenchymal stem cells into the root canal space of necrotic immature teeth after clinical regenerative endodontic procedure', 37: 133-38.

Majno, G, and I Joris. "Cells, Tissues, and Disease, 2nd edn, 2004." In.: Oxford, London, UK: Oxford University Press.

Martin, David E, Jose Flavio A De Almeida, Michael A Henry, Zin Z Khaing, Christine E Schmidt, Fabricio B Teixeira, and Anibal %J Journal of endodontics Diogenes. 2014. 'Concentration-dependent effect of sodium hypochlorite on stem cells of apical papilla survival and differentiation', 40: 51-55.

Marx, Robert E %J Journal of oral, and maxillofacial surgery. 2004. 'Platelet-rich plasma: evidence to support its use', 62: 489-96.

Mohammadi, Zahed %J International dental journal. 2008. 'Sodium hypochlorite in endodontics: an update review', 58: 329-41.

Mohammadi, Zahed, Sousan Shalavi, and Hamid %J European journal of dentistry Jafarzadeh. 2013. 'Ethylenediaminetetraacetic acid in endodontics', 7: S135-S42.

Murray, Peter E, Franklin Garcia-Godoy, and Kenneth M %J Journal of endodontics Hargreaves. 2007. 'Regenerative endodontics: a review of current status and a call for action', 33: 377-90.

Nakashima, Misako %J Australian Endodontic Journal. 2005. 'Tissue engineering in endodontics', 31: 111-13.

Nakashima, Misako, and Akifumi %J Journal of endodontics Akamine. 2005. 'The application of tissue engineering to regeneration of pulp and dentin in endodontics', 31: 711-18.

Nygaard-Ostby, B %J Acta Odont Scand. 1961. 'The role of the blood clot in endodontic therapy', 19: 323-53.

Nygaard-Ostby, Birger, and OLAV %J European Journal of Oral Sciences HJORTDAL. 1971. 'Tissue formation in the root canal following pulp removal', 79: 333-49.

Pitt-Ford, TR. 2008. *Harty's endodontics in clinical practice* (Wright).

Rafter, Mary %J Dental Traumatology. 2005. 'Apexification: a review', 21: 1-8.
Raja, V Sunitha, and E Munirathnam %J Indian Journal of Dental Research Naidu. 2008. 'Platelet-rich fibrin: evolution of a second-generation platelet concentrate', 19: 42.
Ricucci, Domenico, José F Siqueira Jr, Simona Loghin, and Louis M %J Journal of dentistry Lin. 2017. 'Pulp and apical tissue response to deep caries in immature teeth: a histologic and histobacteriologic study', 56: 19-32.
Ruparel, Nikita B, José Flávio Affonso De Almeida, Michael A Henry, and Anibal %J Journal of endodontics Diogenes. 2013. 'Characterization of a stem cell of apical papilla cell line: effect of passage on cellular phenotype', 39: 357-63.
Shi, Songtao, Stan %J Journal of bone Gronthos, and mineral research. 2003. 'Perivascular niche of postnatal mesenchymal stem cells in human bone marrow and dental pulp', 18: 696-704.
Smith, AJ, H %J Critical Reviews in Oral Biology Lesot, and Medicine. 2001. 'Induction and regulation of crown dentinogenesis: embryonic events as a template for dental tissue repair?', 12: 425-37.
Smith, AJ, PJ Lumley, PL Tomson, and PR %J Clinical oral investigations Cooper. 2008. 'Dental regeneration and materials—a partnership', 12: 103-08.
Sonoyama, Wataru, Yi Liu, Dianji Fang, Takayoshi Yamaza, Byoung-Moo Seo, Chunmei Zhang, He Liu, Stan Gronthos, Cun-Yu Wang, and Songtao %J PloS one Shi. 2006. 'Mesenchymal stem cell-mediated functional tooth regeneration in swine', 1: e79.
Svensäter, Gunnel, L Chávez de Paz, and Else %J Textbook of endodontolgy. 2nd ed. Singapore: Wiley-Blackwell Theilade. 2010. ‹The microbiology of the necrotic pulp': 95-110.
Thesleff, I, and A %J Proceedings of the Finnish Dental Society. Suomen Hammaslaakariseuran toimituksia Vaahtokari. 1992. 'The role of growth factors in determination and differentiation of the odontoblastic cell lineage', 88: 357-68.
Torabinejad, Mahmoud, and Noah %J Journal of endodontics Chivian. 1999. 'Clinical applications of mineral trioxide aggregate', 25: 197-205.
Trevino, Ernesto G, Amol N Patwardhan, Michael A Henry, Griffin Perry, Nicholas Dybdal-Hargreaves, Kenneth M Hargreaves, and Anibal %J Journal of endodontics Diogenes. 2011. 'Effect of irrigants on the survival of human stem cells of the apical papilla in a platelet-rich plasma scaffold in human root tips', 37: 1109-15.
Vainio, Seppo, Irina Karavanova, Adrian Jowett, and Irma %J Cell Thesleff. 1993. 'Identification of BMP-4 as a signal mediating secondary induction between epithelial and mesenchymal tissues during early tooth development', 75: 45-58.
Xu, L, L Tang, F Jin, X-H Liu, J-H Yu, J-J Wu, Z-H Yang, Y-X Wang, Y-Z Duan, and Y %J Journal of periodontal research Jin. 2009. 'The apical region of developing tooth root constitutes a complex and maintains the ability to generate root and periodontium-like tissues', 44: 275-82.
Yamauchi, Nozomu, Hideaki Nagaoka, Shizuko Yamauchi, Fabricio B Teixeira, Patricia Miguez, and Mitsuo %J Journal of endodontics Yamauchi. 2011. 'Immunohistological characterization of newly formed tissues after regenerative procedure in immature dog teeth', 37: 1636-41.
Yang, Bo, Gang Chen, Jie Li, Qing Zou, Dan Xie, Yali Chen, Hang Wang, Xiaohui Zheng, Jie Long, and Wei %J Biomaterials Tang. 2012. 'Tooth root regeneration using dental follicle cell sheets in combination with a dentin matrix-based scaffold', 33: 2449-61.
Yang, Xuechao, Fang Yang, X Frank Walboomers, Zhuan Bian, Mingwen Fan, John A %J Journal of Biomedical Materials Research Part A: An Official Journal of The Society for Biomaterials Jansen, The Japanese Society for Biomaterials,, The Australian Society for Biomaterials, and the Korean Society for Biomaterials. 2010. 'The performance of dental pulp stem cells on nanofibrous PCL/gelatin/nHA scaffolds', 93: 247-57.
Yildirim, Sibel, Alp Can, Mustafa Arican, Mildred C Embree, and Jeremy J %J American journal of dentistry Mao. 2011. 'Characterization of dental pulp defect and repair in a canine model', 24: 331.
Zhang, Chayvis Z, Huika Li, William G Young, P Mark Bartold, Changming Chen, and Michael J %J Growth Factors Waters. 1997. 'Evidence for a local action of growth hormone in embryonic tooth development in the rat', 14: 131-43.