International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Calcium Phosphate Bioceramic as Apical Barrier Material in Complicated Endodontic Cases - A Case Report

Gusiyska A.[1], Dyulgerova E.[2]

[1,2]Department of Conservative dentistry, Faculty of Dental Medicine, Medical University – Sofia, Bulgaria

Correspondence: Angela Gusiyska, Department of Conservative Dentistry, Faculty of Dental Medicine, Medical University – Sofia, Bulgaria, E-mail: gusiyska@yahoo.com

Abstract: ***The apical level of root canal preparation and the border of obturation are still discussed in the literature of past decades. Sealers for sealing the root canal space in cases with advanced resorption are also examined thoroughly.Therefore, the development and maintenance of a seal is considered to be a major prerequisite to improving the outcome of root canal treatment.The absence of a physiological narrowing is a challenge to the achievement of satisfactory early and late therapeutic results. It makes probable either the overpressing of necrotic, infected material when preparing the endodontic space or the overpressing of the sealer when sealing the root canal.Despite destroyed apical structures, bone tissue possesses the capacity for regeneration, but there are many pathological situations in which this capacity is not sufficient to stimulate and realize the healing processes. The development of biphasic calcium phosphate ceramics for bone graft and apical barrieris one of the promising contemporary biomaterials for better control of the complex processes of bone healing and regeneration.***

Keywords: apical barrier, apical sealing, biomaterials, biphasic calcium phosphate ceramics, root canal sealer.

1. Introduction

One of the main principles of endodontic science is the 3-dimensional root canal filling, with a focus on filling the apical third of the root. Obturation becomes a more predictable stage, when the walls of the root canal form a physiological narrowing apically, suggesting the preparation of an apical stop that facilitates the proper application of the chosen filling method (paste and gutta-percha) – a central cone technique, hot and cold condensation or hot injection methods [21,25, 47].

Chronic periapical lesions are characterized by changes in the adjacent bone structure and periodontal ligament, as well as the cement and dentine. In a large percentage of the cases with chronic periapical lesions, the anatomically separated physiological constriction is ether absent or expanded.The absence of a physiological constriction is challenging to the achievement of satisfactory early and late therapeutic results. It makes probable either the overpressing of necrotic, infected material when preparing the endodontic space or the overpressing of the sealer when sealing the root canal [19].

The apical level of root canal preparation and the border of obturation are still discussed in the literature of past decades. Sealers for sealing the root canal space in cases with advanced resorption is also examined thoroughly. In the most favorable cases with vital extirpation, the healing process that occurs in the apical zone is related to mineralization in the apical zone upon isolation of the root canal space from the periapical space with a suitable sealer and gutta-percha. Clinical studies have shown that the observance of aseptic preparation of the endodontic space and the availability of a distance from the apical pulp tissue stimulate the natural healing process. The healing occurs with the formation of cement-like tissue, ifan appropriate sealer is chosen[11, 19, 32, 37, 41].

A root filling may entomb surviving bacteria, and prevent apical and coronal leakage, i.e. stop influx of periapical tissue-derived fluid from nourishing the remaining microbiota and thus prevent re-infection of the root canal system [31,42].Therefore, the development and maintenance of a proper seal is desirable and considered to be a major prerequisite to improving the outcome of a root canal treatment[20,24].Ideally, the root canal sealer should be capable ofbonding simultaneously to the root canal walls. Beside irregularstructures such as accessory root canals, resorptionand repaired resorption areas, there are a lowernumber of dentinal tubules, irregular secondary dentine and cementum-like tissue in the apical portion ofthe root canal wall [27]. Physiological phenomena such as tubular sclerosis and dentinal fluid transudation must also be considered in technique-sensitive treatment approach when the apical constriction is resorbed in teeth with chronic apical periodontitis (CAP) [5,30].

Apexification is a procedure well recognized and accepted by clinicians and researchers alike. Calcium hydroxide has long been used as an apexification material.The major problem in cases of a wide open apex is the need to limit the apexification material at the apex, thus avoiding the extrusion of a large amount of material into the periodontal tissue. The use of a matrix is advisable because its placement in the area of bone destruction provides a base on which the sealing material, especially MTA or bioceramic sealer can be placed in apical third [22].Despite a correct endodontic treatment or retreatment,in some cases periapical pathology persists.From this point of view there is a need of material which could be placed orthograde and at the same time stimulate the healing processes in this area. Recently, nanobioceramics have attractedattention for their effective bioactive properties [36,46].Many studies have shown that bone forming cells for specific application are interacting

with the nanoscale surfaces of biomaterials, which is critical to keep the body from rejecting artificial parts [44] and promote the adhesion, proliferation and differentiation of osteoblasts [4, 10].

2. A Case Report

A 21-year-old woman with a non-contributory medical history presented with a painless swelling in the maxillary left anterior sulcus. The patient gave a history of trauma to heranterior teeth when she was 17 years old. The central incisors have been extracted 4 years ago. Intraoral examination revealed that tooth 22 is discolored. Tooth 22 failed to respond to thermal and electric pulp testing, at the same time the adjacent teeth responded within normal limits. Periodontal probing revealed a normal and intact gingiva.

A periapical radiograph revealed a large radiolucent lesion PAI5 (*according to Ørstavik*) (Figure1)[29]. Careful examination of the radiograph revealed that tooth 22 had a periapical radiolucency measuring approximately 9 mm in diameter. The patient complained of occasional pain in tooth 22. Hence, it was decided to treat tooth 22.

Following endodontic access preparation, there was drainage of yellow straw-colored fluid from tooth 22. The root canal space of tooth 22 was negotiated and the working length was measured. The apical foramen was gauged using hand K-files, and the apical width was found to be equivalent to a size 40 K- file. The apical zone was prepared to a size 80 K-file. Various authors have suggested that the minimal final working width at working length for central incisors can range between 0.3 and 0.9 mm [26]. In this case, the constriction was not widened, and an apical stop was prepared. A needle was attached to a syringe and was inserted through the root canal past the apical foramen into the periapical lesion. Colored fluid was aspirated whilst simultaneous digital pressure was applied on the swelling in the labial sulcus. The swelling decreased in size completely once the fluid evacuation was complete. This minimizes the discomfort that the patient might experience. It is a simple technique that aids in decreasing the hydrostatic pressure in the periapical lesion without the need for special equipment [43]. It was made atemporary diagnosis of a radicular cyst.

Cleaning and shaping of the canal was completed, and the tooth was temporized with intracanal medicament - $Ca(OH)_2$ for two weeks. After 2 weeks, the patient was still asymptomatic. The application of calcium phosphate bioceramic in periapical zone was done with specialized armamentarium - Micro Apical Placement System [9, 12]. Definitive obturation of root canal system was done with AH Plus sealer and thermoplastic gutta-percha.

3. Results

The results were evaluated both clinically and radiographically. The clinical evaluation included assessment of: 1/ edema, 2/ postoperative pain (palpation and percussion), 3/untoward reaction. In the present study, healing was evaluated on theevidence of the radiographic appearance. This haslimitations, as the nature of the tissues that were formedwithin the healed lesions is unknown.

The extent of the periapical lesion was large at the beginning. The use of biphasic calcium phosphate ceramics as apex barrier material in such lesions is an attempt to improve the regenerative healing process and to create appropriate conditions for root canal obturation.The radiographic status was monitored at the 1st, 3rd, 6st12th month and after 4 years, as required by European Society of Endodontology [28].A radiograph after 4 year shows complete healing of the periapical lesion of the tooth (Figure 1 a-h).

4. Discussion

A number of obturation materials and techniques have been used over the years. Due tothe complexity of the root canal system, numerous techniques like single cone technique, lateralcondensation, vertical condensation, latest heat delivery gutta-percha system, have been innovated to ensure better seal.

Figure 1: a/initial radiograph on the tooth 22**; b/** control radiograph after obturation; **c**/1st monthafter obturation;**d**/3rd monthafter obturation; **e**/6st monthafter obturation; **f**/ 12th monthafter obturation; **g**/magnification of periapical zone of the initial situation; **h**/ magnification of periapical zone 4 years after obturation.

Gutta-percha was used first by Dr. G. A. Bowman in 1867 and since then it hasbecome a commonly used root canal obturation material [8], but it alone cannot seal the canal

space as it has no adherence to dentin [18]. Sealer plays a major role in filling the space between gutta-percha and canal wall and helps in adherence of gutta-percha to canal wall. Thickness of sealer layer influences the sealing ability of root canal filling [13]. Selection of the sealer is one of the important steps in the treatment of CAP. Endodontic treatment has significantly evolved in the last 20 years, but the treatment of apical zone is a key challenge in the clinical practice. Inadequate obturation may result in the failure of endodontic treatment especially in apical periodontitis.Numerous studies have been conducted to evaluate the success and failure of endodontic treatment [23, 34, 40]. Apical leakage is considered to be a common cause for endodontic therapy failure, and it is influenced by many variables such as different filling techniques, the physical and chemical properties of sealers and the presence or absence of a smear layer (6, 48).Contemporary materials and techniques allow selecting products according to different clinical situations, especially in cases with apical resorption and cases with open apex [9, 12].

It has been determined that approximately 60% of endodontic failures are due to inadequate obturation of the root canal system [7]. Such failures have been attributed to penetration of substances from the apical tissues into the canal. Additionally, failure could be caused by irritants left in the canal that may seep out through an inadequate seal into the periapical tissues [38].

To overcome such problems, Lemon in 1992 introduced the 'internal matrix concept'.Lemon advocated the use of a matrix when perforation diameter is larger than 1 mm to avoid extrusion of the sealing material. The use of a matrix is advisable since its placement in the area of bone destruction provides a base on which the sealing material can be placed and packed [3].Following the ideology of Lemon we applied biphasic calcium phosphate ceramics in the treatment of CAPas apex barrier material, in order to create a biomimetic apical stop and exact root canal obturation to achieve maximum sealing.The results of the present study indicate that theadditional use of biphasic calcium phosphate ceramics in conventional orthograde endodontic therapy of large (PAI5) endodonticlesions may contribute to improved clinical outcome. It is the opinion of the clinician that to follow a correct techniqueof application with an appropriate armamentarium at the right place is a key factor for predictablegood results with biphasic calcium phosphate ceramics.
It is known that calcium phosphate bioceramic materials are more effective in bone repair and regeneration than monophase HAP or b-TCP ones, and have a controllable degradation rate to a certain degree [15, 39, 45].Composites of b-TCP and HAP biphase phosphates combine the excellent bioactivity of the two phases: the good osteoconductivity of HAP and the high properties of resorbability (bioresorbability) of b-TCP [14, 35].

New products based on nanotechnology increasingly emulate nature, and this requires a profound understanding of how nature works at the nanoscale. To achieve this, research teams need to be multidisciplinary and increasingly working together to find innovative solutions to what might have previously been considered intransigent problems.

The healing processes and achievement oftissue regeneration in these cases illustrates several interesting problem points:

- Periapical bone regeneration
- Bacteria tight seal of root-end filling
- Dentine bio-modification [33]
- Cell migration [29]
- Blood supply.

To understand regeneration of the apical periodontal structures, it is useful to recall the basic concepts of repair aswell as regeneration. Repair occurs when the healingprocess results in the formation of new tissue with cellsand structures that have the ability to react differentlyfrom the original ones. Regeneration takes place whenthe previous existing tissue, damaged by pathology, isreplaced by a new tissue identical to the former in cellcomposition, structure and reactivity. In Endodontics, as in Periodontics, this implies formation of newbone, new periodontal ligament and new cementum in periapical zone,i.e. new attachment formation [16].

5. Conclusion

The results of this clinical study show that the use of modified bioceramic as a filling of apical zone and traditional obturation technique stimulate healing processes in chronic apical lesions. Biomimetical obturation of dental apex and filling of the apical periodontal lesion stimulate the remodeling healing processes in the periodontal zone. It is expected that the used bioactive material has complex, multifactorial characteristics, different and probably mimicking bio-tissue functionality. Based on the literature review and clinical-radiographic results presented in the article, it might be concluded that large periapical lesions measured by the *index of Ørstavik*- PAI 5 and clinical findings evaluated for group IV, have the potential for regeneration when using biphasic calcium phosphate ceramics as bone-replacing materials during regenerative tissue process.

References

[1] Andreasen JO, Andreasen FM. Textbook and color atlas of traumatic injuries to the teeth. 3rd ed. St. Louis: Munksgaard& Mosby, 1994;370-2.
[2] Bergenholtz G, Spangberg L. Controversies in Endodontics. Crit. Rev. Oral Biol. Med., 2004;15(2):99-114.
[3] Blumenthal N, Singiser R. The enhancement of Guided Tissue Regeneration by altering root surface topography. International Journal of Periodontics and Restorative Dentistry1993;13: 361–71.
[4] Castellucci A, Papaleon M. The MAPSystem:Aperfect carrier for MTAin clinical and surgical endodontics. Roots 2009; 3: 18- 22.
[5] Chersoni S, Acquaviva G, Prati C, et al. In vivo fluid movement through dentin adhesives in endodontically treated teeth. Journal of Dental Research 2005;84:223–7.
[6] Cruse WP, Bellizzi R. A historic review of endodontics: 1689–1963—Part 1. J Endodon 1980;6:495–9.

[7] European Society of Endodontology. Quality guidelines for endodontic treatment: consensus Report of the European Society of Endodontology. – Int. Endod. J 2006;39: 921–930.
[8] Green HA, Wong M, Ingram T. Comparison of the sealing ability of four obturation techniques. J Endod 1990 Sep; 16 (9): 423 - 28.
[9] Gusiyska A, Dyulgerova E. Remodeling of periapical lesions scaffolding by biphase calcium phosphate ceramics – A pilot study. Journal of IMAB 2009;15(2): 113–118.
[10] Gusiyska A. 'Orthograde treatment of chronic apical periodontitis - Biological approaches' PhD Thesis, Medical University, FDM, Sofia-2012.
[11] Gusiyska A. Periapical resorptive processes in chronic apical periodontitis: an overview and discussion of the literature. J IMAB 2014 ;20(5):601-605.
[12] Gusiyska A,Ilieva R. Nanosize Biphasic Calcium Phosphate used for Treatment of Periapical Lesions. International Journal of Current Research 2015;7(1): 11564-11567.
[13] Ingle JI, Bakland LF Endodontics. 4th ed. Philadelphia: Lea &Febiger; 1994.
[14] Fahi M, Hanifi A. Evolution and characterization of nanostructure hydroxyapatite powder prepared by simple sol–gel method. Mater Lett 2006; 61: 3978–3983.
[15] Fanovich M. et al. Structural analysis of modified hydroxyapatite powders.Mater. Res. Bull2001; 36: 487–496.
[16] Fernandes, M., I. De Ataide. Non-surgical management of a large periapical lesion using a simple aspiration technique: a case report. Int. Endod. J., 2010, 43, 536–542.
[17] Jou Y, Karabucak B, Levin J, Liu D. Endodontic working width: current concepts and techniques. Dental Clinics of North America 2004; 48 , 323–35.
[18] Kytridou V, Gutmann JL, Nunn MH. Adaptation and sealabilityof two contemporary obturation techniques in the absence of the dentinal smear layer. Int Endod J 1999 Nov; 32(6): 464-74.
[19] Lemon R. Nonsurgical repair of perforation defects. Internal matrix concept. Dent Clin North Am 1992; 36(2):439-457.
[20] Leonard JE, Gutmann JL, Guo IY (1996) Apical and coronal seal of roots obturated with a dentine bonding agent and resin. Int Endod J 1996;29:76–83.
[21] Leonardo M, Silva A, Leonardo R, Utrilla L, Assed S. Histological evaluation of therapy using a calcium hydroxide dressing for teeth with incompletely formed apices and periapical lesions. J. Endod., 1993, 19, 348–52.
[22] Lowenguth R, Bliedent T. Periodontal regeneration: root surface demineralization. Periodontology 2000, 1993;1:54– 68.
[23] Lucena-Martín C, Ferrer-Luque CM, González-Rodríguez MP, Robles-Gijón V, Navajas-Rodríguez de Mondelo JM. A comparative study of apical leakage of Endomethasone, Top Seal, and Roeko Seal sealer cements. J Endod 2002; 28, 423-426.
[24] Mannocci F, Ferrari M. Apical seal of roots obturated with laterally condensed gutta-percha, epoxy resin cement, and dentin bonding agent. J Endod 1998; 24: 41–4.
[25] Maroto, M. et al. Treatment of non-vital immature incisor with mineral trioxide aggregate (MTA). – Dent. Traumatology, 2003, 19, 165–9.
[26] Matsumoto T, Nagai T, Ida K, Ito M, Kawai Y, Horiba N, et al. Factors affecting successful prognosis of root canal treatment. J Endod. 1987;13:239–42.
[27] Mjör I, Smith M, Ferrari M, Mannocci F.Thestructure of dentine in the apical region of human teeth. Int Endod J 2001; 34:346–53.
[28] Nery E, LeGeros R, Lynch K, Lee K. Tissue response to biphasic calcium phosphate ceramic with different ratios of HA/bTCP in periodontal osseous defects. J Periodont 1992; 63: 729–735.
[29] Ørstavik, D., K. Kerekes, H. M. Eriksen. The periapical index: a scoring system for radiographic assessment of apical periodontitis. – Endod. Dent. Traumatol., 1986, 2, 20–34.
[30] PaquéF, Luder HU, Sener B, Zehnder M. Tubular sclerosis rather than the smear layer impedes dye penetration into the dentine of endodontically instrumented root canals. Int Endod J 2006; 39:18–25.
[31] Paqué F, Sirtes G. Apical sealing ability of Resilon/Epiphany versus gutta-percha/AH Plus: immediate and 16- months leakage. Int Endod J 2007;40:722–729.
[32] Patel S, Dawood A, Whaites E, Ford Pitt T. New dimensions in endodontic imaging: part 1. Conventional and alternative radiographic systems. Int Endod J. 2009;42:447-462.
[33] Pecora G, etal.The use of calcium sulphate in the surgical treatment of a 'through and through' periradicular lesion.Int Endod J 2001; 34:189–197.
[34] Pommel L, Jacquot B, Camps J (2001) Lack of correlation among three methods for evaluation of apical leakage. J Endod 27, 347-350.
[35] Price R. et al. Osteoblast function of nanophase alumina materials: influence of chemistry, phase and topography. J Biomed Mater Res, Part A. 2003; 67A(4): 1284–1293.
[36] Price R. et al. Nanometer surface roughness increases osteoblast adhesioncarbonnanofiber compacts.J Biomed Mater Res. Part A, 2004;70A (1): 129–138.
[37] Ricucci D, Gröndahl K, Bergenholk G. Periapical status of rootfilled teeth exposed to the oral environment by loss of restoration or caries. Oral Surg Oral Med Oral Pathol. 2000;90:354-359.
[38] Ruy H, Yuoun H, Hong K, Chang B, Lee C, ChungC.An improvement of sintering property of b-tricalciumphosphate by addition of calcium pyrophosphate. Biomaterials 2002;23:909–914.
[39] Salas J. et al. Effect of Ca/P ratio and milling material on the mechanochemical preparation of hydroxyapatite. J Mater Sci Mater Med 2009; 20: 2249–2257.
[40] Sjogren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990;16:498–504.
[41] Sood R, Kumar H, Shetty S.Apical barrier technique with mineral trioxide aggregate using internal matrix: a case report.CompendContinEduc Dent. 2012;33(6):e88-90.

[42] Sundqvist, G., D. Figdor, S. Persson, U. Sjogren. Microbiologic analysis of teeth with failed endodontic treatment and the outcome of conservative re-treatment. – Oral Surg. Oral Med. Oral Pathol. Oral Radiol.Endod., 1998, 85, 86–93.
[43] Swartz DB, Skidmore AE, Griffin JA. Twenty years of endodontic success and failure. J Endod. 1980;9:198–202.
[44] Wan Y. et al. Adhesion and proliferation of OCT-1 osteoblast-like cells on micro and nano-scale topography structured poly(L-lactate). Biomaterials 2005; 26:4453–4459.
[45] Wang J, Chenang W, Lee Y, Fan S, Weng J, Zhang X. Biological evaluation of biphase calcium phosphate ceramic vertebral laminae. Biomaterials, 1998;19(15):1387–1392.
[46] Washburn N. et al. High through put investigation of osteoblast response to polymer crystallinity: influence of nanometer-scale roughness of proliferation. Biomaterials 2004; 26: 1215–1224.
[47] Webber, R. T. Apexogenesis versus apexification. – Dent. Clin.North. Am., 1984, 28, 669–697.
[48] Wu MK, De Gee AJ, Wesselink PR. Leakage of four rootcanal sealers at different thickness. Int Endod J. 1994 Nov; 27 (6): 304 - 8.

Author Profile

Dr. Angela Gusiyska received her degree in Dentistry (Dr. med. Dent) from the Faculty of Dental Medicine, Medical University of Sofia, Bulgaria in 1997 and she specialized in Operative Dentistry and Endodontics at the same University in 2003. Since 1998 she is Assistant Professor at the Department of Conservative Dentistry, FDM – Medical University, Sofia. Her research interests are in the area of regeneration of periapical zone, nanotechnology and bioceramics in endodontics and esthetic rehabilitation of dentition. Dr. Gusiyska presents her scientific papers on national and international dental meetings. Her practice is focused on microscopic endondontic treatments. She developed her PhD thesis titled "Orthograde Treatment of Chronic Apical Periodontics – Biological Approaches: in 2011. She is currently a member of the Bulgarian Dental Association, Bulgarian Scientific Dental Association, Bulgarian Endodontic Society, Bulgarian Society of Aesthetic Dentistry, International Team for Implantology, Bulgarian Society of Oral Implantology.