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

Some Contemporary Requirements for Maximum Sealing of Endodontic Space from the Apical Zone to Orifices - Case Series

Gusiyska A.

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: ***In a number of researches, experimental methodologies and reviews of the endodontic literature concerning failed root canal treatment lack of adequate sealing (coronary and apically) was indicated. A penetration is formed between the sealer and the wall of the root canal. There are also scientific reports of infiltration between sealer and gutta-percha and the sealer in itself. Penetration of sealer into the open dentintubules increases adhesion and sealing of the radicular part of the tooth. The importance of coronal sealing in the long-term success of endodontic treatment has been known for more than 100 years. Early researches in the area of endodontics focused on the quality of coronal sealing and the consequences of unsatisfactory restoration, did not receive the necessary scientific attention. The problem with reinfection of the dentin in already filled root canals has begun to be addressed since the mid-80s of the last century.***

Keywords: apical width, apical zone, microleakage, orifices, pulp floor, sealing, temporary restoration.

1. Introduction

For the past two decades we have witnessed a large number of innovations in the methods of treatment with regards to the techniques and tools in order to improve the understanding of biological approaches to the treatment of clinical cases of osteolysis and absorption of tissue in the periapical area.These innovations reduce the iatrogenic failures, facilitating diagnosis of a lesion in the initial stages, but they can not completely eliminate the problems associated with long-term treatment benefit.

Innovative materials, equipment and techniques continue to sophisticate endodontic procedures and to increase the frequency of predictable clinical success. In current endodontic practice, success has been associated with regeneration, prevention of apical tissues and preservation of the functionality of the tooth. Local and systemic factors affecting long-term function of the natural teeth should be considered in clinical decisions, in addition to the localization process, the quality and quantity of environmental bone and the condition of the other teeth in the dentition.

2. Aim

This article presents some of the latest requirements for maximum sealing of endodontic space from the apical zone to coronary tissues.

3. Apical Width

Extrusion of the filling material in the case of open apex is a result of the available resorptive processes andof overinstrumentation of physiological constriction. Endodontic treatment, which is characterized by a homogeneous canal obturation has a positive effect on the outcome of that treatment [11, 14, 15, 21, 27, 28, 31], as well as survival of the tooth [32]. Achieving an exact restoration of the canal system without overfilling of the teeth with CAP is the basis for the introduction of orthograde sealing the apex with MTA or bioceramics sealers in roots with apical width of more than 400µm (#040 ISO)[9, 16, 17, 18, 36].

The use offormaldehyde releasedroot canal sealers is subjected to critical analysis and modern endodontic practice eliminates their application. Some of the critical issues in their use are: shrinkage during curing and incomplete curing, which creates lack of maximum sealing of endodontic space; overfilling in periapical space of sealer and gutta-percha, which causes a reaction type "foreign body reaction" and leads todelay the healing process and reduces the success rate of treatment; changes in the structure of the dentin, resulting in a microleakage of dentin tubular system in contact with the filling pastes.A certain percentage of cases, recorded as failure in retreatment of these teeth as part of achieving a radicular and coronary sealing, includeundesirable coloring of hard dental tissues as a major problem in modern endodontic treatment due to the high aesthetic demands of the patient. The use of these standard sealers is being replaced by new and improved sealers, such as epoxy sealers, calcium hydroxide base sealers, adhesive sealer and bioceramic sealers for definitive obturation of root canal system [3, 6, 16, 19, 23].
In the presence of resorptive processes in the apical zone, the use of these sealers is critical for obturation of the root canal system, due to the possibility of overfilling with sealer into the periapical space and delay of the healing process or the inability to develop one. All these elements are indication of apexification or surgical treatment of the lesion - eliminating overfillingobturation, curettage and retrograde sealing.

In a number of researches, experimental methodologies and reviews of the endodontic literature concerning failed root canal treatments indicate lack of adequate sealing (coronary and apically). The penetration is formed between the sealer and the wall of the root canal. However there are scientific reports of infiltration between sealer and gutta-percha and the sealer in itself. Penetration of sealer into the open dentin tubules increases adhesion and sealing of radicular part of the tooth. [22].

Evidence-based data of current requirements for good endodontic treatment applied to the principles of tissue engineering in the periapical area are based on scientific basis of the requirement for the application of materials that stimulate recovery processes, as well as the best possible seal from the apical zone to restoration of the coronary hard dental tissues[3, 13, 17, 18].

Over the past 20 years of the last century a lot of the innovation in bone tissue regeneration has been introduced in medicine, but only a small part of the biological knowledge is in endodontics [25]. It should be noted that the development of tissue engineering leads to a promising approach to bone regeneration and restoration of bone tissue after being lost due to endodontic inflammation, trauma or periodontal diseases [7]. Although bone tissue has the ability to regenerate, there are many pathological situations in which this capacity is not sufficient to stimulate the healing process [20]. In the ideology of bone tissue engineering there is the presence of base ("scaffold"), which mimics the natural bone in its chemical composition and volume to facilitate implants integration and subsequent bone formation. In this connection, calcium phosphate biomaterials are considered appropriate choice [8, 9, 24, 26].

In general clinical practice cases with pathologically open apex are not always accurately diagnosed and thus the choice of treatment approach is not properly selected. There are few cases of extraction as a result of the inability of an exact root canal obturation. In some cases retrograde approach obturation is administered, in others multiple applications of $Ca(OH)_2$ paste or use of MTA in the apical seal.In order to prevent extrusion of the material, the applied technique is not always controlled radiographically[1].

Maximum effective apical sealing process in the cases of resorption is related to the determination of the working length by combining at least two of the followingmethods - tactile, radiographic,electrometrical, method of Rosenberg (method of absorbent paper point) and determination of the working width.Clinical width of apical constriction is measured with the last instrument (the ISO taper of .02), which can pass freely through the apical constriction after electrometric determination of the working length.This parameter, along with the working length provides information on the 3-dimensional characterization of the apical region (*Figure 1a, b*).Determining the working width with a certain endodontic instrument (0.02 taper),provides information only for small diameter for incorrect elliptical shape of this type of apical constrictions. In endodontics, this term was introduced by Dr. Jou of University of Pennsylvania [12]. In his article S. Senia cites Carl Hawris, who calls working width "*forgotten dimension*" [32].

4. Temporary Restoration of Coronary Hard Dental Tissues

Treatment of teeth with chronic periapical lesions in most cases is carried out by multi-appointment and therefore requires necessary

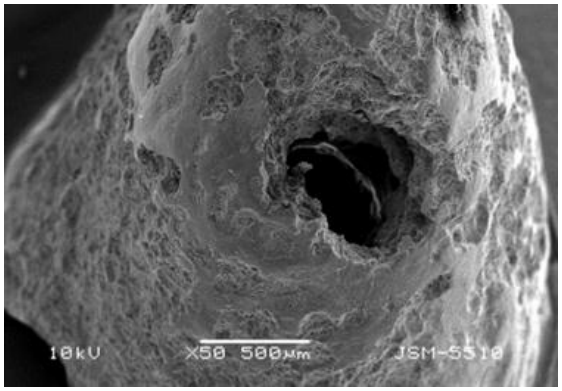

Figure 1a: SEM (x 50) of root apex on the tooth 44: pathological resorption and pathological width in the apical zone–500 µm (#050 ISO).

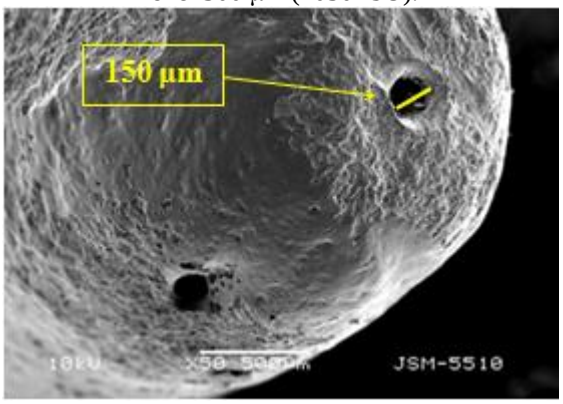

Figure 1b: SEM(x 50) of root apex on the tooth 16: apex with two foramen with physiological width–150 µm /yellow line/ (#015 ISO).

conditions for maximum temporary containment of the drug for long-term intracanal application.A as well as a possibility for isolation in clinical manipulation - stable fixation of rubber dam. Frequent clinical findingsare the lack of wall cusp or extensive destruction of coronary tissues.

In these cases, to ensure good conditions for temporary sealing and fixation of clamp must restore the missing tissues to the completion of ednodontic treatment. One of the clinical choices is adhesive restoration with composite material and creating endodontic access for maximum isolationof root canal, irrigation, aspiration, intermediate and definitive sealing (*Figure 2,3*).

The choice of material for sealing the access cavity should be made with a particular attention, especially in teeth undergoing multi-appointment retreatment. Materials which in their composition have plaster /Calcium Sulphate/(eg. *Coltosol, Coltene*)absorb moisture very quickly and increase significantly their volume. This process leads to undesirablefracturesin devitalized teeth [5, 35].

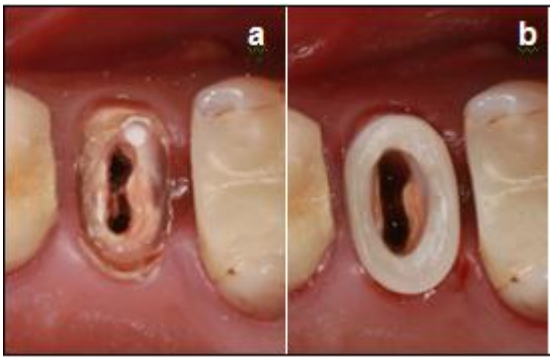

Figure 2: a/initial clinical situation of treatment of the tooth 25; **b**/ adhesive restoration ofthe damaged coronary tissues.

Figure3.a/initial clinical situation of treatment of the tooth 26; **b**/ adhesive restoration ofthe damaged coronary tissues and placed rubber dam.

An important factor associated with failed endodontic treatments is coronal microleakage andhas great effect on proper quality and final coronal restoration. In order to increase the success of the manipulation, with the possibility of reducing the penetration of bacteria and endotoxin through the root canal obturation a definitive sealing at the same visitis recommended [4, 2]. Sometimes this is neglected and may not always be realized in clinical practice. It is a known fact that temporary fillings do not seal sufficiently effective coronary hard dental tissues.Obligatory condition for the final sealing of the canal is adhesive sealing of the orifices and the pulp chamber floor (furcation area)(*Figure 4a-d*). Theendodontic access can be sealed with a temporary obturation until the next visit.

All these studies and many others prove the significance of coronary definitive seal of the state of large periapical tissues - the possibility of recovery after treatment and prevention from reinfection.

5. Preparation of orifices and pulp chamberfloor for sealing

After the definitive root canal obturation and radiographic control of the outcome, the clinician should prepare orifices and pulp floor for adhesive sealing. The application of the flowable composite in the root canals associated withcontamination of the walls and the floor of the pulp chamberis presented in the clinical case (*Figure 7 a, b*).

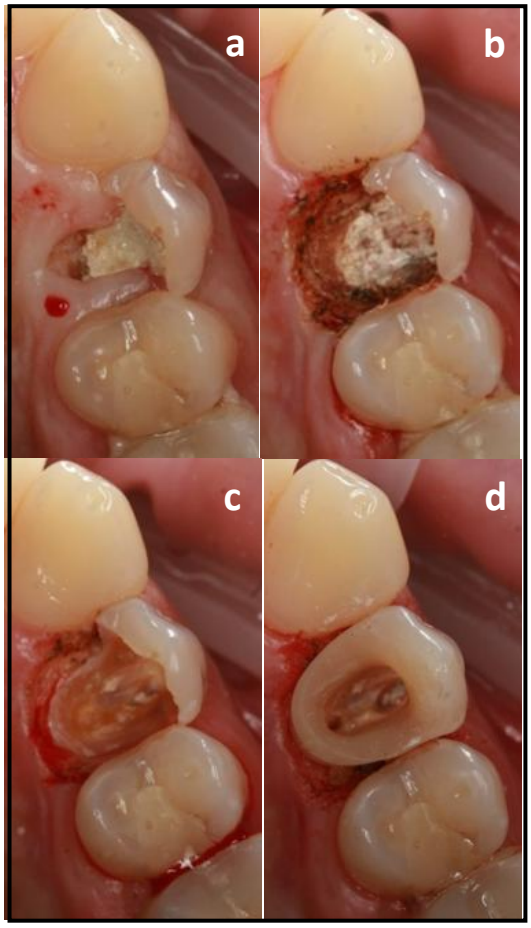

Figure4. Stages of preparation for restoration of coronary tissues - **a**/ initial intraoral situation of the tooth 24; **b**/gingivectomy with Laser; **c**/caries removal and location of the orifices; **d**/adhesive restoration of the damaged coronary tissues, which provides the opportunity to fix a rubber dam and continuing the treatment in aseptic conditions.

Removal of the smear layer of the furcation area can be done with chelating agents, such as EDTA, citric acid or air abrasion - Prophyflex, Airflow(*Figure 5a, b, c*). The materialsfor sealing the floor of the pulp chamber should be in a contrastingcolor, which is necessary for easy access to the orifices of root canal system at next treatment (milkywhite, purple, etc.).

Figure 5: a/ Prophyflex (KaVo)

Figure 5: b/Air Flow (EMS)

Figure 5: c/Air Flow (NSK)

The materials for sealing of the bottom and the orifices havetwo very important characteristics - thixotropic and radiopacity. Radiopacity is of particular importance for radiographic control of coronary sealing (*Figure 6 - yellow arrow*). Cleaning with a dry cotton pellet or cotton pellet soaked in a solution is not enough to remove smear layer from dentin (*Figure 7b*). Level of gutta-percha in root canals remained about 1.5 mm apically to the level from the floor of the pulp chamber, thus obtaining retention niches orifices that increase the stability of the restoration and increase the area of the adhesive bond.

Adhesive sealing of the root canal obturation requires the removal of excess gutta-percha and sealer (*Figure 6*). The polishing of the pulp chamber floor with powder(40-65 μm) effectively remove sealer and prepares for adhesive sealing preserving and preparing the collagen network of the adhesive (*Figure 7c, 8a*).

Figure 6: The level of root canal filling stay apically on the level of the floor of the pulp chamber (marked in blue line); adhesive sealing of the orifices and the pulp floor (yellow arrow).

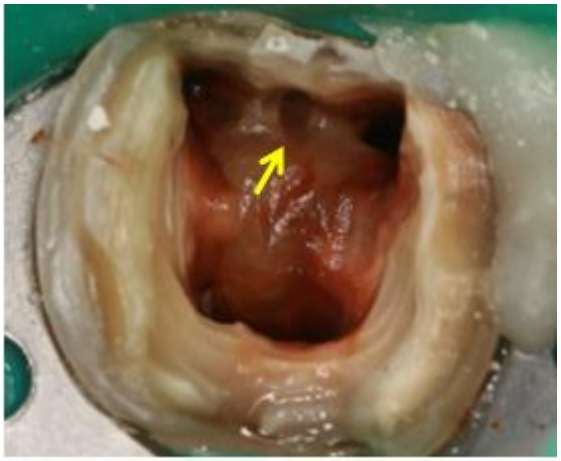

Figure 7: a/ Endodontic access for treatment of tooth 46; location of mesial third canal (yellow arrow); orifices and canals are prepared for obturation.

Figure 7: b/ Obturation of root canals and orifices.

Next stage is application of the sealant to seal the orifices in a contrasting color to that of the dentin (*Figure 7d, 8b*). In cases where there are indications for placement of universal radicular post or metal post restoration in multirooted teeth, these manipulations are applied to the orifices in whichthere will be no preparation for radicular post. The coronary hard dental tissues are restored adhesively. The definitive restoration is related to the overall plan of treatment and indications - crown, onlay, direct composite filling.

Figure 7: c/ Pulp chamber floor after polishing and application of adhesive system.

Figure 7: d/ sealing orifices with flowable composite with a contrasting color - milky white.

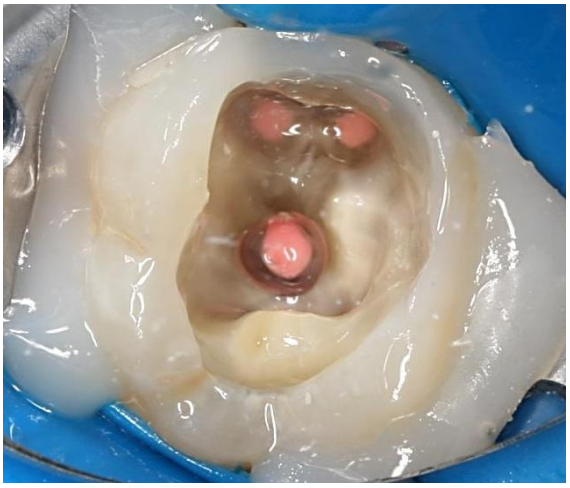

Figure 8: a/ Pulp chamber floor after polishing and application of adhesive system.

Tay (2007) discusses the concept and possibilities of the dentin adhesive materials to achieve one single recovery - monoblock in endodontics [33, 34]. The importance of coronal sealing in the long-term success of endodontic treatment has been known for more than 100 years. Early researches in the area of endodontics focused on the quality of coronal sealing and the consequences of unsatisfactory restorationdid not receive the necessary scientific attention.

Figure 8: b/ sealing orifices with flowable composite with a contrasting color - milky white.

The problem with reinfection of the dentin in already filled root canals has been addressed since the mid-80s of the last century. Articles published between 1969 and 1999 (most of them through the 90s) suggest that the prognosis of the dentin endodontic treatment can be improved by sealing the canal and minimizing leakage of oral fluids and bacteria in the periradicular zone. This need to be done as quickly as possible after the end of treatment [10, 30].

The purpose of the obturation phase of endodontic treatment is to prevent the reinfection of the root canals that have been biomechanically cleaned, shaped and disinfected by instrumentation, irrigation and medication procedures. Successful obturation requires the use of materials and techniques capable of densely filling the entire root canal system and providing a fluid tight seal from the apical segment of the canal to the cavo-surface margin in order to prevent reinfection. This also implies that an adequate coronal filling or restoration be placed to prevent oral bacterial microleakage. It has been shown that endodontic treatment success depends both on the quality of the obturation and the final restoration [29].If healing of pulpal and periapical disease is to be predictable, a proper diagnosis and treatment plan is essential. The clinician should also utilize an evidence-based approach to treatment applying knowledge of anatomy and morphology, and endodontic techniques to the unique situations each case presents. It is crucial that all canals are located, cleaned, shaped, disinfected and sealed from the apical minor constriction of the root canal system to the orifice and the cavo- surface margin. Clinicians should know their level of competency and experience levels when performing endodontic treatment, and work within these parameters or refer the case to an endodontist.

6. Conclusion

The importance of sealing of the root canal space is proven by many scientific research studies and reports of clinical cases. The analysis of the various stages of the protocol of endodontic treatment and the importance of each one of them, require fromus to be precise in the performance of each stage. Improvements in technology and innovations in the restorativematerials, enablea qualified dental practitioner to achieve satisfactory results in the treatment and prevention of periapical lesions.

References

[1] Al-Kahtani, A. et al. In-Vitro Evaluation of Microleakage of an Orthograde Apical Plug of Mineral Trioxide Aggregate in Permanent Teeth with Simulated Immature Apices. J Endod 2005; 31(2): 117–119.
[2] Ashkenaz PJ. One-visit endodontics. Dent Clin N Am 1984;28:853–63.
[3] Best, S. M., A. E. Porter, E. S. Thian et al. Bioceramics: past, present and for the future. JEuropean Ceramic Society 2008; 28: 1319–1327
[4] Calhoun RL, Landers RR. One-appointment endodontic therapy: a nationwide survey of endodontists. J Endod 1982;8:35–40.
[5] Damman D, et al. Coronal microleakage of restorations with or without cervical barrier in root-filled teeth.Rev Odonto Cienc 2012;27(3):208-212.

[6] De Moor, R. J., J. G. De Boever. The sealing ability of an epoxy resin root canal sealer used with five gutta-percha obturation techniques. Endod DentTraumatol 2000; 16: 291–297.
[7] Ellingen, E. J., P. Thomsen, P. Lyngstadaas. Advences in dental implant materials and tissue regeneration.Peridontology2000, 2006; 41: 136–156.
[8] Gusiyska A. Histologic and electron microscopic periapical tissue examination results in teeth with chronic apical periodontitis. J of IMAB 2014; 20(5):642-647.
[9] Gusiyska A, Ilieva R. Nanosize Biphasic Calcium Phosphate used for Treatment of Periapical Lesions. International Journal of Current Research 2015;7(1): 11564-11567.
[10] Heling I, Gorfil C, Slutzky H, Kopolovic K, Zalkind M, Slutzky-Goldberg I.: Endodontic failure caused by inadequate restorative procedures: review and treatment recommendations. J Prosthet Dent 2002; 87(6):674-8.
[11] Hommez, G. M. G., C. R. M. Coppens, R. J. G. De Moor. Periapical health related to the quality of coronal restorations and root fillings. Int Endod J 2002; 35: 680–689.
[12] Jou, Y., B. Karabucak, J. Levin, D. Liu. Endodontic working width: current concepts and techniques. – Dental Clinics of North America, 2004, 48, 323–35.
[13] Kaplan A. et al. Rheological properties and biocompatibility of endodontic sealers. Int Endod J 2003; 36: 527–532.
[14] Kerekes K, Tronstad L. Long-term results of endodontic treatment performed with a standardized technique. J Endod 1979; 5: 83–90.
[15] Kirkevang, L. L., D. Ørstavik, P. Hörsted-Bindslev, A. Wenzel. Periapical status and quality of root fillings and coronal restorations in a Danish population. Int Endod J 2000; 33: 509–515.
[16] Koch, K., D. Brave, A. Nasseh. Bioceramic technology: closing the endo-restorative circle, part 1. Dent Today 2010; 29: 100–105.
[17] Koch, K., D. Brave. A new day has dawned: the increased use of bioceramics in endodontics. Dentaltown 2009; 10: 39–43.
[18] Kossev, D., V. Stefanov. Ceramics-based sealers as new alternative to currently used endodontic sealers. Roots 2009; 1: 42–48.
[19] Kuzmanova, Y. Sealer based on calcium hydroxide-Part II. An internal comparative analysis.Dental review, 2004, 2, 138–143 /in bulgarian/.
[20] Le Geros, R. Z. Properties of osteoconductive biomaterials: calcium phosphates. Clin OrthopRelat Res 2002; 395: 81–98.
[21] Lupi-Pegurier, L., M.-F. Bertrand, M. Muller-Bolla, J. P. Rocca, M. Bolla. Periapical status, prevalence and quality of endodontic treatment in an adult French population. Int Endod J 2002; 35: 690–7.
[22] Mamotil K, Messer H. Penetration of dentinal tubules by endodontic sealer cements in extracted teeth and in vivo. Int Endod J 2007;40:873-81.
[23] Mironova J, Vasileva R, Genova K. In vitro study of apical sealing of root canals associated with adhesive root canal sealers. Online Journal - BZS(15/10/2011,http://journal.bzs.bg/index.php?option=com_content&view=article&id=101:in-vitro-a-&catid=36:2009-12-03-13-38-33&Itemid=59.
[24] Murugan, R., S. Ramakrishna. Development of cell-responsive nanophase hydroxyapatite for tissue engineering. Am J Biochem Biotech 2007; 3(3): 118–124.
[25] Nair, P. N. R. Apical periodontitis: a dynamic encounter between root canal infection and host response. Periodontol 2000 1997; 13: 121–148.
[26] Nasseh, A. The rise of bioceramics. – Endodontic Practice US, 2009; 2: 17–22.
[27] Ørstavik, D. Radiology of apical periodontitis. In: Ørstavik, D., Pitt, Ford T. R. Essential endodontology, prevention and treatment of apical periodontitis, 2-nd ed. Oxford, Blackwell Science Ltd, 2008.
[28] Ørstavik, D., G. Farrants, T. Wahl, K. Kerekes. Image analysis of endodontic radiographs: digital subtraction and quantitative densitometry. Endodontics and Dental Traumatology 1990; 6: 6–11.
[29] Ray HA, Trope M. Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. Int Endod J 1995; 28:12-18.
[30] Ree, M., R. Schwartz.The endo-restorative interface: current concepts. Dent Clin Nort Am 2010; 54(2),:345–374.
[31] Sjögren, U., D. Figdor, S. Persson, G. Sandqvist. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. Int Endod J 1997; 30: 297–306.
[32] Steve, Senia E. Canal Diameter: The Forgotten Dimension. Dentistry Today 2001; 20: 58–62.
[33] Tanomaru, Filho M., M. R. Leonardo, L. A. da Silva. Effect of irrigating solution and calcium hydroxide root canal dressing on the repair of apical and periapical tissues of teeth with periapical lesion. J Endod 2002; 28: 295–299.
[34] Tay, F., D. Pashley. Monoblocks in root canals: A hypothetical or a tangible goal. J Endod 2007; 33(4): 391–398.
[35] Tennert C, Eismann M, Goetz F, Woelber JP, Hellwig E, Polydorou O. A temporary filling material used for coronal sealing during endodontic treatment may cause tooth fractures in large Class II cavities in vitro.Int Endod J. 2015;48(1):84-8.
[36] Thong, Y. L., H. H. Messer, C. H. Siar, L. H. Saw. Periodontal response to two intracanal medicaments in replanted monkey incisors. Dent. Traumatol 2001; 17: 254–259.

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.