RESEARCH ARTICLE

Application of bioceramic endodontic sealers in clinical practice

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Abstract

Objective: To assess the attitude of dental medicine practitioners towards the usage of bioceramic endodontic sealers in their clinical practice.

Method: The survey-based study was conducted from March 2019 to February 2020 in Plovdiv, Bulgaria, after approval from the ethics review committee of the Medical University of Plovdiv, and comprised dentists of either gender who attended in person events organised by the Bulgarian Dental Association. Data was collected using a self-reporting 20-item questionnaire. Data was analysed using SPSS 26.

Results: Of the 200 forms distributed, 164(82%) were duly filled; 52(32%) from males and 112(68%) from females. The overall median age was 46.50 years (interquartile range: 21 years). Mean work experience was 23.68±11.43 years. Significant differences were found between the application of bioceramic sealers and the type of acquired specialty, the endodontic obturation technique and the final irrigation solution ($p<0.05$).

Conclusion: Majority of the respondents did not feel the need to change the endodontic obturation technique in order to adopt the usage of bioceramic sealers.

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Introduction

The basic principle in any treatment is "Primum non nocere" (first, do no harm). In its long-term evolution, science has always sought for development of new materials that are not only unharmful to the body, but also stimulate physiological processes in living organisms. In the context of endodontics, the materials used to obturate the root canals do not deviate from this trend. With the development of technology, new materials come forth that are qualitatively different from their predecessors.

A little more than a decade ago, the first of its kind bioceramic endodontic sealer (BCS), obtained entirely by laboratory synthesis of calcium silicate, was introduced in the market[1] in the shape of Biodentine.[2] One of the newest bioceramic endodontic sealers is BioRoot.[3]

In Bulgaria BCS usage has been previously assessed by just one study[4] although there is Bulgarian participation in the development of the BCS iRootSP.[5] Although scientific data regarding the importance of BCS in the success of root canal treatment is now abundant, there is an existing gap on its clinical application and the need of special postgraduate degree in endodontics.[6]

The current study was planned to assess the attitude of dentists towards BCS use in their clinical practice.

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Subjects and Methods

The survey-based study was conducted from March 2019 to February 2020 in Plovdiv, Bulgaria, after approval from the ethics review committee of the Medical University of Plovdiv, and comprised dentists of either gender who attended in person events organised by the Bulgarian Dental Association (BDA).

The sample size was calculated using EpiInfo 7.[7] The total number of dentists, registered in the Plovdiv region in 2018 was 1,047.[8] The formula of population survey studies was used to achieve 5% margin of error and 95% confidence level. The outcome probability was assumed to be 10%.[7] The minimum number of participants to be enrolled was 122.

The sample was raised using non-random convenience sampling method. Informed consent was taken from the subjects and those who declined were excluded. Also excluded were responses that were incomplete.

Data was collected using a predesigned self-reporting 20-item questionnaire. The first 10 questions related to socio-demographic and professional characteristics of the respondents, while the second part was about the skills, knowledge and attitude of dentists regarding BCS application.

The validation and reliability testing was done in two stages. Initially, the content validity of the questionnaire was assessed by a group of four specialists in Oral Surgery

(OS), Paediatric Dentistry (PD), Operative Dentistry and Endodontics (ODE) and General Dentistry (GD). The final version of the questionnaire was produced as a result of iterative discussion. Thereafter, the reliability was tested by a group of 32 dental medicine practitioners who had not been part of the first stage. Within a minimum interval of two weeks, they filled in the questionnaire twice. A very good test-retest reliability was achieved with a mean Cohen's kappa coefficient of 0.87±0.15 (range: 0.51-1).

Data was analysed using SPSS 26 and Numbers 6.2 (Apple Inc.). Continuous variables were expressed as mean±standard deviation (SD), or as median and interquartile range (IQR) based on data normality. Categorical variables were expressed as frequencies and percentages. The difference between two proportions was analysed by z-test. Chi-square test was used to assess association between two categorical variables. P<0.05 was considered statistically significant.

Results

Of the 200 forms distributed, 164(82%) were duly filled; 52(32%) from males and 112(68%) from females. The overall median age was 46.50 years (interquartile range: 21 years). Mean work experience was 23.68±11.43 years (Table).

Most of the respondents 146(89%) completed their education in Plovdiv, and 132(81%) had a contract with the National Health Insurance Fund (NHIF). Only 9(6%) respondents did not execute endodontic treatment (ET) in their clinical practice. Most 91(56%) indicated that they conduct ET 1-3 times per week, and 24(15%) conducted it on a daily basis.

The daily performance of ET was more common among specialists in ODE than among those who had no specialty (z=3.6, p=0.0003). PD 7(78%) and GD 14(74%) specialists as well as those without a specialty 64(62%) performed ET 1-3 times a week compared to ODE specialists 3(14%) (z=3.4, *p*=0.0006; z=3.8, *p*=0.0001; and z=4, *p*<0.0001, respectively). Practice without ET was more common among OS specialists (67%) than those with no specialty (3%) (z=6.7, *p*=0.0001). Regarding the selection of cases, requiring monitoring of the healing process or the average follow-up period, no significant differences were found among the specialties (*p*=0.101 and *p*=0.076, respectively).

Table: Characteristics of the respondents (n=164).

	n (%)
Gender	
Males	52 (32.00)
Females	112 (68.00)
Age (years)	
≤30	31 (19.14)
31-40	63 (38.89)
41-50	36 (22.22)
51–60	22 (13.58)
>60	10 (6.17)
Practice location*	
City	(93.25) 152
Rural	(9.75) 11
Type of practice*	
Individual practice	103 (62.81)
Group practice	59 (35.98)
Dental Faculty	41 (25.00)

*multiple choice question with more than one option for answer.

ODE specialists used the obturation technique of a single gutta-percha cone with setting paste in 95% cases, while OS specialists used it only in 33% (z=3.0, *p*=0.003). Those with GD specialty (37%) preferred filling the root canal only with setting pastes, even more often than those without a specialty (11%) (z=2.9, *p*=0.004).

Only 9(6%) subjects used BCS exclusively, and 43(16%) used them in specific cases. Most of the dentists 73(47%) said BCS affected the healing process post-ET, while 24(15%) did not think so. The remaining 58(37%) said they could not judge such a relationship.

Respondents aged >60 years (50%) used formalin-resorcin (FR) endodontic sealers significantly more often than those aged 31-40 years (17%) (z=2.1, *p*=0.038). Filling root canals only with setting pastes was preferred by those aged >60 years (80%) compared to the other age groups (45%) (z=2.1, *p*=0.038).

Those with GD specialty (42%) used FR endodontic sealers significantly more often than ODE specialists (5%) (z=2.8, *p*=0.005). ODE specialists (71%) preferred using the new BCS significantly more often than GD (11%) and PD (10%) specialists as well as those without a specialty (24%) (z=4, *p*<0.0001; z=3.2, p=0.002; and z=4.2, *p*<0.0001, respectively). Despite the high percentage of respondents with an NHIF contract (81%), most clinicians who used BCS (47%) did not have a contractual relationship with it (z=2.6, *p*=0.008).

Practitioners in the dental faculty conducted ET daily (22%) and applied BCS (49%) significantly more often than the ones with individual practice (ET: 9%; BCS: 24%) (z=8.1, *p*<0.0001: and z=2.8, p=0.006, respectively). Clinicians who performed ET >3 times a week used BCS (49%) and preferred the technique of single cone (92%) and setting paste (5%) more often than those who performed it 1-3 times a week (BCS: 18%; single cone technique: 68%; and setting paste: 20%) (z=3.6, p=0.0003; z=2.9, *p*=0.004; and z=3.5, p=0.0006, respectively). The difference between the two groups in terms of information about the

incompatibility of combining BCS with warm root canal obturation techniques was significant (23% vs. 77%) (z=3.3, *p*=0.0009).

As a final irrigation solution, 71(37%) respondents preferred alcohol, followed by sodium hypochlorite 37(19%) and hydrogen peroxide 31(16%), while 29(15%) preferred to complete the irrigation cycle with saline (z=3.3, *p*=0.001). Those who used saline (79%) considered price to be the main limiting factor for BCS use than those who irrigated with alcohol (46%) (z=3.0, *p*=0.003).

A small number 40(33%) of dentists used warm techniques for obturation of root canals, distributed almost equally between the technique with obturator 18(15%) and warm vertical condensation 22(18%). Although the largest number (57%) of subjects used the single cone technique, the majority using BCS applied them with the method of warm vertical condensation (59%) rather than with the single cone technique (29%) (z=2.7, *p*=0.006).

The reason for placing a non-setting calcium hydroxide medicament in the root canal varied among the respondents. The most common answers included exudation 65(42%), bleeding 58(38%), severe pain 57(37%), and odour 45(29%). Those who monitored their cases for >2 years used it before applying BCS (67%), and not because of the gangrenous odour in the root canal (16%) (z=2.8, *p*=0.005).

The average follow-up period for 35(23%) subjects was >2 years, for 54(35%) 1-2 years, and for 51(33%) subjects 6-12 months. Regarding the method for assessing the healing process – 146(94%) subjects relied on a clinical examination combined with anamnestic examination and conventional radiography. Some of the respondents 5(3%) believed that they did not need an X-ray examination and evaluated the results only clinically, while others 3(2%) did not even conduct a clinical examination, and relied only on the anamnesis.

Discussion

Before the advent of bioceramic tricalcium silicate endodontic sealers, the materials used to obturate the root canal system had varying degrees of hydrophobic nature. The only way to achieve three-dimension (3D) obturation of the root canal system is to utilise the properties of the thermoplasticised gutta-percha.[9] It is now proven that this new group of materials is not compatible with the techniques of thermoplasticised gutta-percha.[4,10,11] It can be concluded that the majority of dentists from Plovdiv region (70%) used techniques that were fully compatible with BCS. ODE specialists were well aware of this problem and preferred to apply them with the cold single cone technique in over 95% of their cases. Despite their exceptional properties, BCS are not indicated to be used as a stand-alone root filling material.[5,11-16] Nowadays, the technique of filling root canals only with paste is not recommended for definitive filling due to poor control of the level of obturation and the high probability of the formation of pores. Filling the canals only with paste is used only as a method for long-term treatment with a non-setting agent. The unpredictability of the filling makes this method unsuitable for definitive obturation of the root canal.[17,18]

Another issue related to the nature of BCS is the final irrigation protocol. The most common agent facilitating the drying of the root canal is alcohol and the majority of respondents (37%) in the current study used it as a final irrigation solution. Such a requirement is lacking in the instructions for BCS use. On the contrary, there are BCS variations available only in pre-mixed containers and designed for direct application in the root canal. They have a requirement for moisture present in the root canal, essentially needed for their setting reaction.[18-20] Saline solution is the best means of evacuating the active irrigant solution present in the root canal, as it has no active properties and does not facilitate the drying of the canal. This detail is important in order to avoid the risk of suboptimal hardening of the material due to lack of moisture in the root canal.[19,20]

FR pastes (sealers) are one of the oldest root-filling materials. Although their usage is no longer recommended for clinical application, they are still preferred by some clinicians, probably due to their long-term experience, which has led to establishing a personal professional stereotype of work. In the past, FR sealers have been widely used due to their antibacterial and mummifying effect on residual necrotic parts of the extirpated dental pulp.[21] Modern techniques for removing necrotic masses and materials from the root canal by conical preparation and assisted irrigation eliminate the need for fixation of organic tissues.[22] In addition, there is evidence that these materials release formalin, which is toxic to the periapical tissues, which has led to their withdrawal from the recommendations for clinical use.[15] Although formaldehyde is known to have carcinogenic and mutagenic effect on skin and on the lungs, when inhaled, formaldehyde fumes are found not to be a common irritant in the working environment among Bulgarian dentists.[23,24] Bioceramic sealers release non-toxic calcium hydroxide during their setting process, which plays a key role in determining their antimicrobial properties and partly in the mechanism of adhesion of the material to the root canal wall.[14]

Literature shows the unpredictability of the setting reaction of BCS at low potential of hydrogen (pH) of the medium.[13,14,16] The current survey showed that only 4% dentists were aware of this problem and applied a non-setting calcium hydroxide medicament to increase the pH of the medium before filling with BCS. The reason for the low awareness probably lies in the fact that due to the recent appearance of these materials, training for their use is not included in the curriculum of dental students. Bioceramics are the newest type of endodontic sealers, which are beginning to enter the material taught at the Faculty of Dental Medicine, the Medical University of Plovdiv, but are not yet embedded in the clinical training of students.

The coronavirus diseasae-2019 (COVID-19) pandemic determined the reduction in students' practical work with patients.[25] Thus the pandemic played a significant role in the application of new technologies, such as BCS.[25,26]

Although most of the available research on bioceramics is focussed on the material properties,[27] the current study assessed the attitude of dentists towards the application of such materials.

Bulgarian NHIF does not provide financial support for ET of adults regardless of the pandemic. BCS is a new type of material, which currently entails a high cost and its use is typical of highly specialised endodontic practices that deal with complex endodontic cases only, mostly referred by general practitioners. This is in line with another study.[6]

In terms of limitations, the study questionnaire consisted of fixed responses, which narrowed the respondents' opportunity to reflect their own true opinion on the matter.

Conclusion

Although the frequency of ET in Plovdiv region was relatively high, a small number of practitioners used the new BCS materials. This determines the need to search for and adopt new techniques and materials in their clinical practice. It is necessary to increase the level of awareness of dental medicine practitioners in the region about the superior qualities of bioceramic materials.

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