Bioactive materials for root canal obturation

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Introduction

In our previous cases (published in 2012 and 2013) have already described the properties and clinical capabilities of the ROEKO GuttaFlow and GuttaFlow 2 systems (COLTENE), based on the polydimethylsiloxane (PDMS) chemical compound, which is a linear polymer of dimethylsiloxane. The properties are due to the chemical capabilities of the substance. The amount of dimethylsiloxane units in the structure can reach up to 15,000. Depending on the chain length of the polymer, substances with different physical properties can be obtained. The viscosity of such compounds increases with increasing length, which corresponds to a transition from very motile, gas-like liquids, to more viscous oils and, finally, to resinous substances.

Cold obturation technique for bioactive sealing and filling

The GuttaFlow and GuttaFlow 2 systems operate on the principle of absolute bio-inertness. All materials and substances used in clinical dentistry can be conditionally divided into three major groups:

1. Bio-inert: do not interact with surrounding tissue
2. Bio-resorptive: during contact with surrounding tissue are absorbed and/or destroyed
3. Bioactive: affect the surrounding tissue during contact.

Given the increased interest of clinicians and researchers in the bioactive methods of root canal obturation, the new bioactive system of cold free-flow gutta-percha was created by COLTENE. The system was based on the
already existing GuttaFlow and GuttaFlow 2 and given all the best qualities of its predecessors. GuttaFlow bioseal (Fig. 1) was created according to the formula of sealer + free-flow gutta-percha + bioglass and consists of the following components:

- basis with gutta-percha (in powder form with a particle size of less than 30 μm), zinc oxide and barium phosphate
- bioglass
- sealer with PDMS, silicone oil, paraffin oil, zinc dioxide (X-ray contact slowness), platinum catalyst, colouring pigment and micro-crystals of silver (bactericidal effect).

Such an arrangement provides to the system, in addition to the unique properties of GuttaFlow, a number of characteristics:

- no need for mechanical compaction;
- the presence of a prolonged bactericidal effect;
- obturation on the principle of no heating, no shrinkage (0.2% expansion);
- excellent fluidity;
- simplicity and speed of clinical use; and
- the ability to absorb hydroxyapatite crystals on the biocrystal particles (the importance of this property and its role in determining the clinical effectiveness of the system are explained later in the article).

The properties of bioglass as a material capable of contacting the native bone were first described in 1969.\(^9\) It consists of silicon, calcium oxide, hydroxyphosphates and sodium phosphates. Today, owing to the expressed osteoinductive effect, bioglass is widely used in medicine (e.g. traumatology and dentistry). Owing to its high pH, antibacterial properties are strongly pronounced. Thus, GuttaFlow bioseal has unique chemical, physical and bioactive properties regarding the formation of hydroxyapatite crystals, the main structural unit of hard tooth tissue, which ensures the maximum quality of sealing and the biocompatibility of the material.\(^10, 11\)

As already mentioned, GuttaFlow bioseal contains a finely dispersed gutta-percha, PDMS, platinum catalyst, zirconia, silver (preservative) and colourant. In addition to all these, the new material contains finely dispersed particles of bioactive glass-ceramic, which provides the formation of hydroxyapatite crystals on the surface, which causes
excellent adhesion to the dentine and tightness of the obturation. In addition, the presence of silver particles in ceramics, according to some data, has the effect of conservation of the root canal. Nowadays, only mineral trioxide aggregate and bioglass have similar regenerative properties.12, 13

Seven-year follow-up of a clinical case obturated with GuttaFlow 2

Tooth #45 (Figs. 2a & b) was obturated with GuttaFlow 2 and served for seven years as a retainer tooth for a clasp prosthesis, experiencing additional loads. It is evident that the slight extrusion of the material at the apex did not affect the periodontal condition. At the same time, the material was not absorbed, proving its absolute bio-inertness.

Step-by-step protocol

The step-by-step protocol for activating the new system is absolutely identical to that of GuttaFlow 2. Before using the syringe applicator, the protective cap should be removed and replaced with a mixing tip (automix). When the plunger is pressed, the evenly mixed material without bubbles leaves the mixing tip in a 1:1 ratio. Flexible mixing tips can only be used once and must be disposed of after use.

1. It is extremely important to ensure the dryness of the biomechanically processed root canal. For insurance, lay down another one of the same size with an exposure of 40 seconds after removing the last paper point in a dry condition. If it is dry and dense upon removal, you can proceed to obturation.
2. Determine the correct size gutta-percha master point (from the master apical file).
3. Distribute the GuttaFlow bioseal on the mixing block and introduce it into the canal on the master point.
4. Introduce the master point for the entire working length and adapt it.
5. Introduce the tip of the mixing tip to the maximum possible depth (no closer than 5 mm to the apex; the size of the spout corresponds to ISO file size 80) depress the plunger until the material appears in the mouth of the canal, ensuring a gradual and smooth flow from the tip.
6. Cut the master point heated to 200 °C.

Clinical examples obturated with GuttaFlow bioseal

In 2016, the system was applied for clinical approbation at the postgraduate dentistry department of the Voronezh State Medical University named after N.N. Burdenko in Russia. In both cases, endodontic treatment was primary, the apex locator behaved as usual (DentaPort ZX, Morita) and there were no clinical complaints after the root obturation (Figs. 3 & 4).

Molar with chronic fibrous pulpitis

A 47-year-old patient complained of spontaneous radiating pain in the region of the lower jaw on the left that amplified with temperature stimuli. Visual and instrument examination revealed a cavity in tooth #38. After the standard diagnostic protocol, the diagnosis was chronic fibrous pulpitis of tooth #38 (Fig. 5a).

At the request of the patient, endodontic treatment was performed. The preparation was carried out using the HyFlex CM and HyFlex EDM file systems (both COLTENE). The choice of the system is obvious. Once the glide path had been established to ISO size 15, we analysed the pronounced curve (Fig. 5b) and selected a rotary tool for increased flexibility and an obturation system that does not require condensation, which would have been impossible under the conditions. In our opinion, GuttaFlow bioseal coped brilliantly with the task, achieving reliable obturation not only along the entire length of the canals, but also of a pronounced delta in the apical part (Fig. 5c).
Repeated endodontic treatment

A 49-year-old patient presented with acute pain affecting tooth #46. According to the patient, the tooth had previously been treated for compound caries. For ten years, the tooth had been covered with a metal-ceramic crown. The pain had begun three days before, and the patient had visited the clinic where she had been treated previously. After CBCT examination, the patient was referred to the department (Fig. 6a).

After the standard diagnostic protocol, the diagnosis was chronic granulomatous periodontitis of tooth #46. The tooth had previously been treated with resorcinol-formalin method. At the request of the patient, repeated endodontic treatment was performed. After debridement and negotiation of the glide path to ISO size 15 with hand tools (reamer and H-file), the subsequent preparation was carried out using the HyFlex CM system with a standard irrigation protocol (5% sodium hypochlorite, 17% EDTA; water; EndoActivator). The treatment steps at the first visit were canal access, irrigation, preliminary preparation and temporary obturation with UltraCal XS (Ultradent Products) for 14 days.

As there were no complaints at the second visit, the final mechanical and chemical treatment followed by obturation was carried out. The radiographic monitoring (Fig. 6b) showed that the material had extruded into the periapical tissue on the mesial root and covered the resorbed apical part of the root. The radiographic controls after six and nine months (Figs. 6c & d) traced the positive dynamics of regenerative processes after repeated endodontic treatment.

Paranasal sinus diagnosis with surprising finding

A 27-year-old patient was referred to us with no complaints. A radiolucency (Fig. 7a) in the area of tooth #37 was found by accident during CBCT imaging of the paranasal sinuses. Owing to the absence of a clinic near the patient’s home, we decided to conduct a repeat endodontic treatment in one visit. The root canals were sealed with zinc oxide eugenol paste. The retreatment and creation of the glide path to ISO size 15 was carried out with hand instruments (reamer and H-file). Subsequent preparation was done using the HyFlex CM system with a standard irrigation protocol (5% sodium hypochlorite, 17% EDTA, water, EndoActivator). The treatment steps were irrigation, preliminary and final mechanical and chemical treatment, followed by obturation and radiographic inspection (Fig. 7b). At the recall after six months, the patient was without complaints, and radiographic monitoring (Fig. 7c) showed positive dynamics of regenerative processes after endodontic treatment.

Conclusion

GuttaFlow bioseal is the logical continuation of the existing materials of GuttaFlow and GuttaFlow 2, and in addition to its own unique osteoinductive qualities, has the same obturation properties as its predecessors. We express the firm belief that the availability of the GuttaFlow bioseal system in the dentist’s arsenal will significantly expand the clinical possibilities of the endodontic practice, since there is nothing more physiological than the patient’s natural tooth.

Editorial note: A list of references can be obtained from the publisher.

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