Endodontic Surgical Treatment - A Literature Review

Ivan Ivanov[*], Elka Radeva[**], Tsonko Uzunov[**]

[*]Doctor of Dental medicine, Faculty of Dental medicine, Medical University – Sofia, Bulgari
[**]Department of Conservative Dentistry, Faculty of Dental medicine, Medical University – Sofia, Bulgari

Abstract- The aim of the current literature review shows the reasons for endodontic-surgery treatment and its techniques (methods) for its realization. When conservative treatment is not possible because of post with crowns, bridges and consideration of the possibility of weakening of the remaining dental hard tissues, there are reasons for undertaking apical surgery. This can be defined as endodontic-surgery procedures that include apical resection, curettage and retrograde filling. The aim is sealing the root canal in order to eliminate microleakage of periapical tissues. In relation to this literature discusses issues related to the sealing of the root canal and updating of various cements for root canal filling. The access to the apical portion may be provided by a low-speed handpiece with fissure burs or high-energy lasers, supported by microsurgical mirror and microscope. Different ultrasonic tips are an alternative for retrograde root canal preparation. Materials that might be used are: MTA, Biodentin, IRM, EBA, I Root SP, MTA Fillapex, ProRoot Endo Sealer, EndoSequence Bioceramic Root Repair Material. Conclusion: in appropriately selected clinical cases, endodontic-surgical approach gives good and reliable results and should be preferred over the decision for extraction of the tooth and its subsequent replacement by implant therapy.

Index Terms- cements, endodontic surgery treatment, materials, retrograde filling

I. INTRODUCTION

Conceptions for endodontic treatment indicate that root canal therapy conducts on eliminating the reasons leading to periapical lesion. The main method of choice is the orthograde treatment of the infected endodontic system. The result of that treatment shows that in 83% to 97% of following cases there is recovery (1, 2), when the main principles of endodontic treatment are being observed.

The orthograde endodontic treatment includes medical and mechanical treatment and finishes with obturation of the endodontic system. The mechanical treatment starts by using stainless steel files 0.02 taper with an apical-coronal technique (Step Back). This technique does not lead to appropriate shape that is suitable for cold lateral or warm vertical condensation for 3D filling, whereas the use of stainless steel files with large diameter in curved root canals leads to transportation of the natural root canal. Therefore this mechanical treatment, irrigation and filling of the root canal system are insufficient (1, 3, 4, 6, 7, 8, 10, 12). Using crown - down technique the enlargement in the coronal part allows better contact of the irritants with dental tubules. This allows better obturation of the lateral canals with sealer and gutta-percha.

These considerations manage the use of rotary Ni-Ti instruments. Prepared in that way, root canals have less straightening, less transportation of the natural root canal and less perforations (10, 11, 13, 14, 15, 16). Also treated canals are more centered (12) and the natural curvature of the root canal has been saved. Curvatures generate stress in instruments because of the moment of torsion and the cyclic fatigue. In order to prevent and reduce these effects rotary Ni-Ti instruments are used in combination with coronal-apical technique for enlargement. In that way first it is prepared the coronal part of the root canal and then the conditions for treating the apical part are better and the extrusion of debris is less (7-9). However in root canals with high expressed curvatures there is a risk of instrument fracture (6).

II. INDICATIONS

Indications for conduction of apical resection are following:

- Periodontitis chronica apicalis with diameter of the lesion around 5 mm;
- Radicular cysts;
- Good looking radiographically endodontic treatment but with pain;
- Second unsuccessful endodontic treatment;
- Transportation of the apical foramen, perforation in the apical part, ledges and other iatrogenic mistakes and persistent symptoms and pathology;
- Availability of periapical pathology and volume post restorations and bridges in the esthetic zone;
- Calcified root canals with or without symptoms and radiographic pathology;
- Fractured instruments in the apical third of the root canal;
- Unsuccessful conventional endodontic treatment;
- Overfilling and presence of persistent pain;
- Difficult curvature, unavailable in the orthograde treatment;
- Incompact and insufficient length of the root filling;
- Internal resorbtion;
- Need for biopsy of the periapical lesion (17).

In addition, the surgical treatment provides fast mitigation when the drainage is needed and cannot be achieved or it is not sufficient through the root canal (57).

III. CONTRAINDICATIONS

Contraindications for apical surgery are engagement of more than one third of the root surface of the tooth that can break the static of the tooth. Exceptions to the last rule could be allowed in

the frontal zone in order to save esthetics and the ratio root: crown should be at least 1:1 after the resection. Teeth suffering from periodontal disease are not appropriate for endodontic surgical treatment. Anatomical contraindications are: proximity of the periapical pathology to anatomical cavities. Insufficient oral hygienic procedures can compromise the long-term success of treatment (17).

The reasons of failure of the orthograde endodontic treatment could be seen in cases in which the root canal is not instrumented in sufficient volume or complex anatomical variations could be found; reaction antigen-antibody as a result of extrusion of irritants or material (3). Although an important role in the healing process has health status of the patient, the majority of failures are due to the inability to fully removal of the causes that led to the apical pathology. Nowadays conventional endodontic techniques are insufficiently adequate in the case of hard-processing curved canals, lateral canals, fracture of endodontic instruments in the apical part, presence of bulky post restorations, and its removal is risky, availability of various types of resorptive processes of the root system, perforations in apical portion and resistant to conventional medication microbial strains (18, 50, 54, 55, 56). Solving such problems determines the need for the application of more invasive approach to eliminate periapical pathology.

The aim of the current literature review shows the reasons for endodontic-surgery treatment and its techniques (methods) for its realization, announced in the contemporary literature as alternative for saving the tooth instead of extraction and its further replacement with implant therapy.

After depletion of all conventional alternatives and assessment the advantages and disadvantages of implant therapy, the endodontic surgery might be alternative instead of tooth extraction. The success of periapical surgery has been dictated because of the elimination of the infected tissues and hermetic apical filling. In cases in which conservative treatment is not possible because of posts with crowns or bridges and consideration of the possibility of a further weakening of the remaining dental hard tissues of the tooth, there are reasons for undertaking apical surgery (5). This can be defined as endodontic-surgery procedures that include apical resection, apical curettage and obturation.

The aim in periapical surgery is sealing the root canal in order to eliminate microleakage of periapical tissues and a problem after resection of the root tip. In relation to this literature discusses issues related to the sealing of the root canal and updating of various cements for root canal filling and with the method of apex resection of the pathological tooth.

The access to the apical portion may be provided by a low-speed handpiece under water cooling. High-speed handpieces should be avoided because of the risk of emphysema (58). Thesis et al (59) recommend the apical resection to be made with the fissure bur below 90 degrees and the phase is not greater than 10 degrees. At an angle to 10 degrees provides a complete removal of the apical delta and lateral apical tubules. Curetted apical tissues are sent for histopathological analysis. The apex angle of the root tip is most commonly 45 degrees relative to the longitudinal axis of the tooth. It was found that microleakage is influenced by the angle of the cut and the depth of the apical cavity. In the application of the cut angle of 0^0, 30^0 and 45^0 the fewest microleakage was found in section of 0 degrees and at most 45 degrees. This is explained by the area of exposed dentin - the slope of the cut with its growth increases the surface area of exposed dentin and microleakage increases. Regarding the depth of the prepared apical cavity was found that cavity with the depth of 1 mm provides a transmittance of zero for the horizontal section; 2,1 mm and 2,5 mm depth of the apical cavity provide zero leakage under sections respectively 30 and 45 degrees. This demonstrates on one hand the influence of the relationship of the apical cavity depth and slope of the cut and on the other hand microleakage of the retrograde filling on apical infiltration (60). Kim and coworkers found that in 3 mm resection is reached reduction of apical ramifications 98%, in 2 mm resection reduction is about 78%, and in 1 mm - 52%. The study shows that if not removed the apical ramification there is a risk of reinfection and failure (17). Apical cavity depth of 3 mm provides a safe and adequate apical seal (61). Resection of the root tip could be accomplished by fissures and handpiece burs in the clinical setting.

Modern tools imply the use of high-energy lasers group ErCr: YSGG (Erbium Chromium: Yttrium, Scandium, Gallium, Garnet) laser through which could be carried out resection of the root tip to be prepared an apical cavity, as well as used as a hemostatic agent and the disinfection in the apical region (62, 63, 64, 65). The realization of root tip resection with fissure burs causes vibrations and dental cracks that cause unpleasant sensations in the patient, producing contaminating layer and debris, which is a carrier of infection and lead to tissue heating in the area of resection. Hibst and al. stated that the use of the Er:YAG laser for the purpose of resected root apex does not cause thermal damage and carbonization (charring) of the surrounding tissues, and minimal or no discomfort to the patient (66, 67). Takashi Shimizu et al. (68) used Er:YAG laser with the following characteristics: wavelength - 2940 nm, maximum frequency - 20 Hz, pulse power: 80-700 μs. They remove 3 mm of the root apex as in this manner in 98% of the root canals apical branching are eliminated. In conclusion, it may be argued that the use of Er:YAG laser for root tip resection takes less clinical time, no smear layer, which does not require the use of EDTA, which demineralises healthy dentin smear layer below. According to the literature Er:YAG laser sterilizes and inactivates endotoxins (69, 70). Therefore the use of the Er:YAG laser for the purpose of apical resection is clinically effective (68).

Modern endodontic surgery treatment is supported by microsurgical mirror and increases under the microscope, which improves visual control of operative field and assesses the apex for cracks, perforations available channel obturation, prepared apical cavity and subsequent retrograde filling (58).

IV. ULTRASONIC TIPS FOR APICAL CAVITY PREPARATION

The ultrasonic tips are an alternative for retrograde root canal preparation. Using them it is possible to follow the natural course of the root canal. However, the authors describe microcracks in root walls after resection (46, 47). It is studied that these cracks do not affect the sealing of the sealer. The authors compare several types of ultrasonic tips for ultrasound

filling. There were used stainless steel tips, as well as with diamond and zirconium coating. The criteria by which they are compared is the presence of microcracks, the degree of exposure of dentinal tubules and time for which the access cavity was made. The authors make the conclusion that the use of US tips with a diamond coating takes less time for preparing endodontic cavity than with the other groups (48). The study of cavities made with three retro-tips showed no significant difference in the number of microcracks and the exposure of dental tubules. Working with a higher power does not increase microcracks. According to Peters (49) stainless steel ultrasonic tips lead to a smaller number of microcracks.

The preparation of the retrograde cavity by ultrasound is more accurate as compared to low speed handpieces. Diamond-coated tips have more efficient cutting ability and therefore can reach excessive cutting of hard tooth tissues. That is why the work with them should be more careful.

V. MATERIAL REQUIREMENTS FOR RETROGRADE FILLING.

Requirements to the ideal material include: biocompatibility, stability, radiopacity, hardness, ability to harden in a liquid medium, to have antibacterial properties, to be easy manipulated, to have osteoinductive or osteoconductive qualities, to have good adhesion to the canal walls and good apical sealing (20, 21, 22). The ideal filling material used to seal the apical part, prevents the penetration of irritants in the periapical area and the percolation fluid from the periapical tissue in the root canal (20). Filling of root-canal system in view of the upcoming endodontic surgery should be done with hard, non resorbable material. In the past, it was used zinc phosphate cement, in modern endodontics - gutta-percha and sealer termoplastified gutta-percha and epoxy-resin sealer. After flap reflection for access and resection of the root apex, retrograde filling should be done by reliable means. These are: mineral trioxide aggregate (MTA), Biodentin, IRM (Intermediate Restorative Material), ethoxy-benzoyl acid (EBA), I Root SP, MTA Fillapex, ProRoot Endo Sealer, EndoSequence Bioceramic Root Repair Material (ES-BCRR, Brasseler USA) (25, 26).

MTA is composed of a hydrophilic powder mainly composed of calcium oxide. The high level of the apical seal of MTA, compared to that of other materials has been confirmed by several studies (27-31). The main advantages of the material are: biocompatibility, osteoinduction and regenerative potential (32), MTA did not induce cytotoxicity or inflammatory response of the body (25). Some of its disadvantages are: difficult manipulative and slow hardening (33) which may be the reason for the penetration (34) and also surface disintegration (35) and loss of marginal adaptation (36). Some authors have reported that the success in retrograde filling with MTA is higher in comparison with dental amalgam (37) while others come to the conclusion that both materials used in the retrograde filling have similar clinical outcomes (38). Such clinical results were obtained in comparison between MTA and IRM (39, 40).

Biodentin - consists of powder and liquid. The composition of the powder includes: tricalcium silicate (main component), dicalcium silicate, calcium carbonate, iron oxide, zirconium oxide. The liquid is composed of calcium chloride and water-soluble polymer (51). Biodentine is indicated in deep carious lesions, pulp covering perforations in the furcation and roots, internal and external resorption, retrograde filling in the apical surgery. Manipulation time is from 6 to 10-12 minutes. The manufacturer claims that it has excellent sealing properties and is available in capsules. Compared to MTA it has a faster curing, which reduces the risk of bacterial contamination (51). In vitro studies of the same authors showed that the least penetration (0,13 mm) has Biodentin when compared to that in MTA (0,73 mm) and glass ionomer cements (1,49 mm), which puts it in the group of reliable modern means of sealing the root canal.

EndoSequence BioCeramic Root Repair Material (ES-BCRR, Brasseler USA) is used as material for root canal filling and sealing. Main ingredients are calcium silicate, calcium phosphate, zinc oxide. At the market it is available in two forms: powder and paste. Important properties are: biocompatibility and bioactivity, hydrophilic, high pH, which suggests its antibacterial properties and it is easy to apply. Microleakage is greater as compared to MTA (44). In other studies marginal adaptation of the cement is similar to the MTA. In retrograde filling it is recommended to use the one that is in the form of powder due to its higher degree of adjustment in comparison to the other form (45).

ProRoot Endo Sealer (Dentsply, Tulsa Dental Specialties) is calcium silicate sealer, which may be used as root canal filling material with the technique of cold condensation and warm vertical condensation. It consists of powder and liquid. The powder contains: tricalcium silicate, dicalcium silicate and calcium sulfate (for slowing the hardening process), bismuth oxide (radiopaque) and tricalcium aluminate. The composition of the liquid is viscous water-soluble polymer. According to Weller in terms of apical sealing ProRoot Endo Sealer is equivalent to popular epoxy sealer. Compared to the zinc-oxide-eugenol cements, it seals better and demonstrates ex vivo bioactivity when it is in contact with the phosphate ions (41, 42).

MTA Fill apex (Angelus, Brazil) is a relatively new cement-based MTA. It is available in the form of two pastes or double syringe. The manufacturer reported its ability to seal the lateral canals, inability to recolor tooth, as well its ability to prevent recontamination of the root-canal system, release calcium ions, which provide rapid tissue regeneration. The material has improved handling properties compared to MTA. These properties are determined by its composition: Paste 1: silicate resin, bismuth trioxide, silicon dioxide; Paste 2: titanium dioxide, MTA (40%) and an activator. The sealer has improved setting time - 130 minutes with a variation of 10 minutes and manipulation time - 30 minutes according to the manufacturer (43).

I Root SP (Innovative BioCeramix Inc, Canada) - according to the manufacturer this cement represents a prepared white, insoluble, radiopaque paste. The material is insoluble calcium silicate cement that does not contain aluminum. The hardening is carried out by moisture in the dentinal tubules (23). Composition: zinc oxide, calcium silicate, calcium phosphate, calcium hydroxide and fillers. It has strength similar to that of AH Plus sealer (24).

Clinical studies have shown that in the use of **IRM** the success rate was 74%, and in dental amalgam - 57% (18), which is proven by the reduction of the toxicity and improved apical

sealing of the root canal. According to Chong, Ford and others. slightly higher rate of healing of periapical lesions (84% after 12 months and 92% after 24 months) was observed in the MTA compared with IRM (76% after 12 months and 87% after 24 months) (19). The manufacturer determines the setting time - 4 hours while in very dry root canals it can last more than 10 hours. To solidify I Root SP the necessary moisture is taken from the dentinal tubules in the root canal walls. Canal itself should be well dry with paper points before placing in the sealer (52, 53).

VI. CONCLUSION

The data in literature suggests that in appropriately selected clinical cases, endodontic-surgical approach gives good and reliable results and should be preferred over the decision to extraction of the tooth and its subsequent replacement by implant therapy.

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AUTHORS

First author - Ivan Todorov Ivanov, DMD, Grant project - Contract №45/2015, MU-Sofia
Second author - Elka Nikolaeva Radeva, DMD, PhD, Associate Professor, Department of Conservative Dentistry, Faculty of Dental Medicine, Medical University-Sofia, Bulgaria, eliradeva@abv.bg
Third author - Tsonco Todorov Uzunov, DMD, PhD, Associate Professor, Department of Conservative Dentistry, Faculty of Dental Medicine, Medical University-Sofia, Bulgaria

Corespondence Author - Elka Nikolaeva Radeva, DMD, PhD, Associate Professor, Department of Conservative Dentistry, Faculty of Dental Medicine, 1“Georgi Sofiiski” blvd, 1431 Sofia, Bulgaria, e-mail: eliradeva@abv.bg, Phone: +359 888319813