

University of Medicine and Pharmacy of Craiova

Doctoral School



**THE ASSESSMENT OF THE ENDODONTIC STATUS
OF ABUTMENT TEETH OF FIXED PROSTHETIC
RESTORATIONS**

PhD Thesis

ABSTRACT

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Introduction

Reducing the thickness of dental hard tissues, during the preparation of natural teeth to serve as abutment teeth for fixed prosthetic restorations (FPR), can trigger a painful syndrome, even when using temporary provisionals [1]. In addition, the occlusal forces exerted on the abutment teeth can determine alterations of the dental pulp, as described in occlusal trauma [2,3]. Performing root canal treatment on teeth used as abutment for FPR is accompanied by a decreased of their biomechanical resistance and consequent biological changes [4]. Thus, preserving the vitality of future abutment teeth is mandatory in the collaboration between endodontics and prosthetics. Pre- and pro-prosthetic endodontic treatment has specific indications, and non-compliance with these is considered as proof of ignorance of current protocols [5].

CURRENT STATE OF KNOWLEDGE

1. Dentin-pulp complex: structure and functions

It is already recognized in the scientific literature that the dentin and the pulp must be considered as a whole, being called the dentin-pulp complex [6].

The most specific cells of the dental pulp are the odontoblasts, being responsible for dentinogenesis, during both the formation of the tooth and during its lifetime[7-9].They are differentiated post-mitotic cells [10,11], having a very important role in the defensive mechanisms of the dental pulp, [12,13]. Fibroblasts are the most numerous cells in the dental pulp, distributed throughout the pulp and having multiple functions. They are able to produce other cells dedicated to differentiation (cells similar to odontoblasts), but also type I and III collagen, proteoglycans and glycosaminoglycans. Macrophages are derived from monocytes, which have exited the bloodstream and are the main defense cells of the dental pulp, possessing a strong activity [14]. Lymphocytes are commonly found in chronic inflammation situations, but their presence has been also demonstrated in impacted or recently erupted teeth, with

no apparent explanation [15]. The connective fibers of the dental pulp are mainly represented by collagen fibers (type I and III), which are irregularly distributed . The distribution of the fiber types remains constant over the lifetime of the tooth, even if the production rate of these fibers increases directly proportionate to age [16].

When the integrity of the enamel and of the dentin layers is compromised by the evolution of a carious lesion, the dental pulp becomes exposed to bacteria and their metabolites. These invade the entire pulp space through the dentinal tubules, stimulating the pulp immune system to produce an inflammatory response [9,17].

2. Pre-prosthetic root canal treatment

Currently, the indications of the pre-prosthetic endodontic treatment of the American Endodontics Association (AAE) are clearly stated: for over-prostodontics, for teeth that will receive special prosthetic systems, for malpositioned teeth or teeth that will undergo hemysectioning or premolarization; in fixed prosthodontics to ensure the retention of restorations [18].

In general, the purpose of the endodontic treatment is to preserve the functionality of the treated tooth and to eliminate intra-root infection [19], but also to prevent the onset of apical periodontitis [20].

The evaluation of the root canal treatment's adequacy and efficiency has always been a controversial topic in the scientific literature [21]. Some authors claim that the correct assessment of an endodontic treatment provides information on the effectiveness of treatment methods and can help determine specific factors that may influence the treated tooth and the treatment prognosis [22,23].

PERSONAL CONTRIBUTIONS

3. The working hypothesis

The working hypothesis for this research project was based on the clinical finding that periapical complications can occur in vital abutment teeth but also in those with adequate endodontic treatment. Starting from this standpoint, we established the general objective of the PhD thesis, namely to determine the most appropriate therapeutic attitude regarding the endodontic status of FPR abutment teeth.

In order to demonstrate the working hypothesis and to reach the general objective, we established the following specific objectives: (i) evaluation of endodontic status in a group of patients with FPR, (ii) highlighting histological pulpal changes in vital abutment teeth; (iii) identifying, using specific immunohistochemical markers, specific inflammatory cells and cells with regenerative potential; (iv) evaluating endodontic filling techniques adequacy and efficiency, as a prognostic factor for the success of endodontic treatment.

4. Clinical-statistical study of the endodontic status in the abutment teeth of fixed prosthetic restorations

This cross-sectional study aimed to determine the prevalence of chronic apical periodontitis (CAP) within the research group, the frequency of endodontic treatment in the case of FPR abutment teeth, the evaluation of the quality of endodontic treatment from a radiological point of view, correlated with the presence of CAP on tooth groups.

Patients were clinically and radiologically examined (based on an orthopantomography) and consequently observation charts were filled. The research was initially conducted on 472 patients, but the sample size of the study was narrowed to 276 patients, who had at least one fixed denture, or at least one single dental crown.

The quality of the endodontic treatment was evaluated according to the radiological aspect of the obturation and the periapical status. According to these criteria, four groups of root-filled abutment teeth were formed: (1) adequate endodontic obturation, (2) adequate endodontic obturation + CAP, (3) inadequate endodontic obturation, (4) inadequate endodontic obturation + CAP.

The prevalence of radiologically visible CAP was 63.55% for all patients participating in the study (n = 472), and 71.01% for patients with RPF.

The patients with FPR (n= 276) presented a number of 1544 abutment teeth. They were divided into two categories: 1052 abutment teeth with endodontic treatment (68.13%) and 492 abutment teeth without endodontic treatment (31.87%), visible on the orthopantomography. This indicated a preference for performing endodontic treatment in the study group (p <0.05).

Analyzing the distribution of abutment teeth with endodontic treatment by groups of teeth, depending on the quality of the endodontic filling and the presence of CAP, it was observed that the radiologically inadequate endodontic filling accompanied by signs of CAP had the highest proportion regardless of the tooth type (incisors, canines, premolars or molars).

5. Histological study of pulpal changes in the abutment teeth of fixed prosthetic restorations

The aim of this study was to histologically evaluate the dental pulp modifications occurring in abutment teeth or in teeth with simple untreated carious lesions or previously treated ones, that manifest secondary caries or caries recurrence. All these teeth were devitalized for prosthetic purposes.

Of the initial patient group (n = 276), 64 required changing existing FPR. 29 samples of pulpal tissue were taken; 8 of them were damaged during the fixation and staining procedures, so that the final number of samples subjected to the study was 21. The staining techniques used in this study were: Hematoxylin-Eosin (HE), Trichromic, Goldner-Szeckeli and Periodic Acid Schiff (PAS).

The samples were grouped according to the tissue changes observed on the study slides, as follows: 12 samples showed atrophic pulpal changes; 9 samples showed signs of chronic (7) and acute (2) pulpal inflammation

The histological examination revealed that all teeth whose pulpal removal was performed for pre-prosthetic reasons according to the recommendations of the literature showed pulpal modifications, characteristic to atrophy and pulpal inflammation (chronic or acute). Furthermore, amyloid deposits were revealed, which could be a marker for systemic diseases with unfavourable prognosis.

6. Immunohistochemical study of pulpal modifications in the abutment teeth of fixed prosthetic restorations

Given that histologically-analyzed pulpal tissue samples showed inflammatory and atrophic signs, the immunohistochemical study aimed to identify target inflammatory cells and cells with regenerative potential, using specific immunohistochemical markers.

Immunohistochemical procedures were performed on dental pulp samples that histologically showed acute inflammation, using the following markers: CD-3, CD-20, CD-68, tryptase, S-100 protein, α -SMA .

B and T lymphocytes, mast cells, macrophages and myofibroblasts were highlighted. The presence of collagen-secreting myofibroblasts could be an indicator of the potential of the dental pulp tissue to regenerate. These cells require further research, as to date no other studies on human dental pulp are known to clearly demonstrate the presence of myofibroblasts. The structure of nerve fibres that have not been degraded can be an indicator of incipient pulpal inflammation, with possible reversible abilities

7. Microscopic study of endodontic filling sealing ability

The objective was to evaluate the fulfillment of the criteria proposed by AAE for an ideal filling, of endodontically obturated teeth, by three different techniques, using stereomicroscopic examination.

The teeth included in the study (n = 31) were used as abutments under FPRs and were endodontically treated for preprosthetic reasons. They were considered irrecoverable and extracted due to periapical pathological processes or periodontal damage.

Given that the teeth were endodontically obturated many years before, the assessment of the quality of the root canal filling was performed based on the following criteria: (i) the status of the gutta-percha cone and compliance with the working length, (ii) the status of the endodontic paste and its degree of homogeneity, (iii) morphology of the analyzed teeth that influenced the quality of the root canal obturation.

Following the macroscopic examination of the teeth sections and considering the existing scriptural data in the patient files, the endodontic filling technique was established: single cone technique (17 teeth), cold lateral condensation technique (12 teeth), warm condensation technique (2 teeth).

The working length of the root canals was fully covered in the case of warm vertical condensation filled teeth and partially in the case of cold lateral condensation obturated teeth. The warm vertical condensation technique presented the possibility of extrusion of endodontic filling materials throughout the apical foramen.

All sectioned teeth showed voids within the endodontic obturation: in the case of cold filling technique they were macroscopically visible, while in the teeth filled with heated gutta-percha they had sizes of tenths of μms

Regarding the visual characteristics of the endodontic sealer used in addition to gutta-percha, it was dyschromic in cases obturated using the single cone technique, as well as in those using cold lateral condensation technique.

Comparing the three endodontic filling techniques based on the proposed criteria, we could say that none of the analyzed methods fully met the objectives proposed by the AAE. However, most of these requirements were reached by the vertical warm condensation technique.

8. General discussions

The clinical-statistical study showed an increased prevalence (63.55%) of the CAP in a group of patients from Oltenia. Compared to other studies, the prevalence was higher: 47% in a Sudanese population [24], 54.7% in a population in Southern Estonia [25], but also lower: 80% in a study on a population in Belarus [26].

The high prevalence of CAP was associated with the large number of abutment teeth with endodontic treatment (68.13%). The high frequency of endodontic treatment can be explained by pre- or pro-prosthetic indications, but also by the presence of dental lesions that recommend endodontic treatment prior to applying fixed prosthesis. The literature reports a lower percentage of abutment teeth with endodontic treatment (21.17%) [27].

Although it is known that the histopathological diagnosis of pulpal lesions can be influenced by the tissue's sectioning level [28], in the histological study of this research project, the samples were grouped taking into account the patient's subjective symptoms. The main histological aspects observed in the sampled pulpal tissue were: (i) atrophic elements, such as increased number of collagen fibres, numerical reduction of blood vessels, which caused stasis and vascular congestion, diffuse calcifications; (ii) inflammatory elements: increased number of fibroblasts, active vasodilation with increased vascular endothelial permeability, hyperemia and the observation of neofunctional blood vessels and vascular thrombosis [29].

In the existing scientific literature, several methods and techniques for assessing the quality of endodontic obturation have been described, applied on "in vivo", but most often "in vitro" root-filled teeth. Such studies have used optical microscopy [30], micro-computer tomography [31] or optical coherence tomography [32].

Gaps and lack of homogeneity of the endodontic filling are an unfavourable prognostic factor for the longevity of the endodontic treatment

itself. Most filling voids were observed in the case of cold lateral condensation filled-teeth, similar to other research [32,33]. Warm gutta-percha obturation techniques are considered superior for decreasing the possibility of occurring for these filling defects [34].

9. General conclusions and innovative contributions

The chosen research topic is contemporary, as the inter-relationship between endodontics and dental prosthodontics is a constant scientific concern, but current results have not led to a general agreement. Opinions in the literature have always been divided, and the decision to perform root canal treatment on an abutment tooth for a FPR continues to arouse controversy.

This doctoral thesis aimed to establish the best therapeutic attitude regarding the preservation of the vitality of the FPR abutment teeth. Taking into account the clinical situations encountered, in which teeth with endodontic treatment considered to be radiologically correct showed signs of CAP, we formulated the idea that the favourable long-term prognosis of an endodontically treated tooth depends on other elements also, and not only on those related to the endodontic treatment itself.

Based on the current knowledge in these fields, some important conclusions and elements of originality can stem from this doctoral thesis:

1. According to the clinical-statistical study, CAP had the highest frequency in abutment teeth with inadequate endodontic treatment, but nevertheless, there were abutment teeth with inadequate endodontic treatment without radiologically visible apical changes.

2. In abutment teeth with adequate endodontic treatment, the frequency of radiologically visible CAP was considerably lower (molars 2.94% and incisors 1.89%).

3. The absence of apical lesions in some of the teeth with incorrect endodontic treatment, as well as the presence of periapical lesions in the teeth

with correct endodontic treatment, showed that there are other factors involved in the evolution of teeth with endodontic treatment and creates future research directions.

4. From a histological point of view, within the pulpal tissue samples analyzed from abutment teeth, atrophic changes (represented by collagenous fibrosis, stasis, vascular congestion and diffuse calcifications), but also inflammatory manifestations (numerous fibroblasts and inflammatory infiltrate) were highlighted.

5. The histological analysis revealed the presence of amyloid deposits, which could be a marker for systemic diseases with unfavourable prognosis. There are no other current descriptions of amyloid deposits in the dental pulp in the scientific literature, motivating further research as this can be an important signal for systemic diseases with reserved prognosis.

6. The presence of collagen-secreting myofibroblasts could indicate a possible reparatory potential. These cell populations require further research, as to date there are no other studies on human dental pulp known to certainly demonstrate the presence of myofibroblasts. It should be noted that these repairing capabilities of the dental pulp were found in teeth which were abutments for a long period of time, in the patients of considerable age.

7. The microscopic study on the sealing ability of the endodontic obturation highlighted that all the analyzed teeth exhibited voids, regardless of the used filling technique

8. This microscopic study of the endodontic obturation showed that no obturation technique can be considered perfect; however, the technique with the smallest deficiencies was the warm gutta-percha technique.

According to all the performed studies, the best clinical attitude when managing partially edentulous patients for oral rehabilitation purposes, is to respect the integrity of the remaining teeth, as best as possible, or when not

applicable, to cause minimum sacrifice of dental tissues, so that to preserve the pulpal vitality of those teeth.

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