Optimization of Diagnostic Process in Assessing the Extent of Dental Hard Tissue Defects after Endodontic Treatment

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Abstract
The selection of an optimal treatment is one of the problems when restoring the defects of dental hard tissues after endodontic treatment. The work aims at studying the percentage ratio of the volume of the coronal portion of the tooth to its crown that will allow us to optimize the determination of the extent of dental hard tissue defect after endodontic treatment as well as to choose the optimal method of treatment.

The objective of the research was to optimize the diagnostic process when treating damaged coronal portion of the tooth after endodontic treatment through the determination of the percentage ratio of the volume of the coronal portion of the tooth to the total volume of tooth crown for different groups of teeth.

Materials and methods. 42 extracted teeth with preserved coronal portions served as the material for our study. The volume of the coronal potion of the tooth as well as the total volume of tooth crown was determined using the method developed by us. Having calculated the ratio of the volume of the coronal portion of the tooth to the volume of tooth crown, we received the volume which is occupied by the coronal cavity of the tooth.

Results. We obtained the percentage ratio of the volume which is occupied by the coronal cavity of the tooth compared to its crown for different groups of teeth.

Conclusions. To estimate the extent of damage to the coronal portion of the tooth after endodontic treatment, it is recommend using the obtained data, namely, in the maxillary and mandibular front teeth, the coronal portion of the tooth occupies up to 10% of tooth crown volume, while in the maxillary and mandibular grinding teeth, the coronal portion of the tooth occupies up to 5% of tooth crown volume.

Keywords
dental hard tissue defect; tooth cavity; diagnosis; classification; failure index

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Problem statement and analysis of the recent research
Over the last two decades, in the theory and practice of dentistry fundamental changes have occurred: it is currently developing in the exchange relations which dictate their demands not only in the economic sphere, they highlight the need for scientific research and theoretical justification of the most effective methods of diagnosis, treatment and prevention of common dental diseases as well [1]. It is necessary to develop common approaches to regulation, planning and improvement of dental care quality, training and retraining of medical personnel, rational use of human and material resources of dental institutions. The work in this direction should be based on the creation of the standards (algorithms) of providing dental care to the population [2].

The selection of an optimal treatment is one of the problems when restoring the defects of dental hard tissues after endodontic treatment. In clinical crown of vital tooth with the defect of hard tissues, there are two cavities – the internal cavity and the external cavity (Fig. 1). The external cavity occurs due to pathological process, and the internal cavity is the cavity of tooth crown. Clinically (in the patient’s oral cavity), a doctor can estimate the size of the external cavity only. The internal cavity is located in the crown and roots of the teeth. The significant part of this cavity occupies tooth crown. Its size changes throughout the life of an individual. The total measurement of the internal and external cavities is possible only in a devitalized tooth in case of significant dental decay or during treatment of the tooth after endodontic surgery. The amount of the defect of dental hard tissues increases by the volume of the coronal cavity of the tooth. Methods of treatment are changed depending on the extent of tooth crown defect. The pulp chamber volume was studied using radiovisiography [3] and elastomers [4]. The sizes of the pulp chamber are described in modern research works on endodontics and anthropology [5, 6].

The volume of the coronal portion of the pulp chamber itself and the percentage ratio of the volume of the coronal...
portion of the pulp chamber to the total volume of tooth crown for different groups of teeth are important for objectification of the diagnostic process.

Considering the aforementioned data, it is important to study the percentage ratio of the volume of the coronal portion of tooth cavity to its crown that will allow us to optimize the determination of the extent of dental hard tissue defect after endodontic treatment as well as to choose the optimal method of treatment.

The objective of the research was to optimize the diagnostic process when treating damaged coronal portion of the tooth after endodontic treatment through the determination of the percentage ratio of the volume of tooth coronal portion to the total volume of tooth crown for different groups of teeth.

1. Materials and methods

42 extracted teeth with preserved coronal portions served as the material for our study. The volume of the coronal portion of the tooth as well as the total volume of tooth crown was determined through the placement of creamy substance (baby cream) in the cavity of the studied teeth and their impressions using insulin syringes according to the method proposed by us [7].

Each measurement was calculated in absolute values (ml) and the percentage of the volume occupied by the coronal portion of the tooth was determined.

On the studied teeth, the level of the tooth cervical line was indicated using a marker. Creamy substance was injected into dental impression made from silicone-based mass (Zeta Plus) using an insulin syringe (Fig. 2, Fig. 3). The insulin syringe allows monitoring the amount of content and fixing the difference before and after the injection of the substance into dental impression which provides the desired volume of tooth crown of the studied tooth. During the next stage, we cut off the root of the studied teeth up to the tooth cervical line, thereby receiving an access to the coronal portion of the tooth. Creamy substance was injected into the coronal portion of the tooth using an insulin syringe (Fig. 4). Thus, we obtained the volume of the coronal portion of the tooth. Having calculated the ratio of the volume of the coronal portion of the tooth ($V_2$) to the volume of tooth crown ($V_1$), we received the percentage ratio of the volume which is occupied by the coronal cavity of the tooth compared to its crown.

2. Results

The results of the research are presented in Table 1.

3. Discussion

When analyzing the obtained results, the most important indicator was the percentage ratio of the volume of the coronal portion of the tooth ($V_2$) to the volume of the crown ($V_1$) (Table 1).

The ratio of the volume of the coronal portion of the tooth cavity ($V_2$) to the volume of tooth crown ($V_1$) for the maxillary first incisors was $7.77 \pm 0.504\%$. The ratio of $V_1$ to $V_2$ for the maxillary second incisors was $8.43 \pm 0.203\%$; for the maxillary canines it was $9.03 \pm 0.524\%$. 

Figure 1. Scheme of the tooth with hard tissue defect.

1 - the inner cavity of tooth crown;
2 - the external cavity of tooth crown.

Figure 2. Molding procedure.

Figure 3. Creamy substance in dental impression.
Figure 4. Injection of creamy substance into the tooth cavity.

Table 1. Results of measurements of the volume of the coronal portion of the tooth, the volume of the crown and determination of the ratio between them.

| Tooth                        | $V_1$ of tooth crown, ml | $V_2$ of the coronal portion of the tooth, ml | $V_2/V_1$, % |
|------------------------------|--------------------------|----------------------------------------------|--------------|
| Maxillary first incisor, (n=3) | 0.27±0.042               | 0.02±0.002                                   | 7.77±0.504   |
| Maxillary second incisor, (n=3) | 0.17±0.023               | 0.01±0.002                                   | 8.43±0.203   |
| Maxillary canine, (n=3)       | 0.31±0.018               | 0.03±0.001                                   | 9.03±0.524   |
| Mandibular first incisor, (n=3) | 0.16±0.019               | 0.01±0.002                                   | 8.28±0.039   |
| Mandibular second incisor, (n=3) | 0.20±0.015               | 0.01±0.001                                   | 7.47±0.504   |
| Mandibular canine, (n=3)      | 0.25±0.025               | 0.02±0.002                                   | 7.57±0.433   |
| Maxillary first premolar, (n=3) | 0.37±0.015               | 0.01±0.001                                   | 3.57±0.120   |
| Maxillary second premolar, (n=3) | 0.29±0.023               | 0.01±0.001                                   | 3.90±0.100   |
| Maxillary first molar, (n=3)  | 0.52±0.065               | 0.02±0.003                                   | 3.47±0.088   |
| Maxillary second molar, (n=3) | 0.57±0.035               | 0.02±0.0001                                  | 3.37±0.120   |
| Mandibular first premolar, (n=3) | 0.30±0.015               | 0.01±0.001                                   | 4.23±0.145   |
| Mandibular second premolar, (n=3) | 0.38±0.020               | 0.01±0.001                                   | 3.70±0.153   |
| Mandibular first molar, (n=3) | 0.59±0.026               | 0.02±0.001                                   | 3.70±0.173   |
| Mandibular second molar, (n=3) | 0.53±0.029               | 0.02±0.002                                   | 3.57±0.145   |

The ratio of $V_1$ to $V_2$ for the mandibular first incisors was 8.28±0.039%; for the mandibular second incisors it was 7.47±0.504%; for the mandibular canines it was 7.57±0.433%.

The ratio of the volume of the coronal portion of the tooth cavity ($V_2$) to the volume of tooth crown ($V_1$) for the maxillary first premolars was 3.57±0.120%; for the maxillary second premolars it was 3.90±0.100%; for the maxillary first molars it was 3.47±0.088%; for the maxillary second molars it was 3.37±0.120%.

The ratio of the volume of the coronal portion of the tooth cavity ($V_2$) to the volume of tooth crown ($V_1$) for the mandibular first premolars was 4.23±0.145%; for the mandibular second premolars it was 3.70±0.153%; for the mandibular first molars it was 3.70±0.173%; for the mandibular second molars it was 3.57±0.145%.

The results obtained when measuring the volumes of the coronal portion of the tooth are similar to the results obtained by other researches [4, 5, 6]. Considering the fact that the teeth being used in the study were removed in older age and the size of pulp chamber reduces after the age of 30 years [3], the ratio of the volume of the coronal portion of the tooth ($V_2$) to the volume of tooth crown ($V_1$) can be rounded to the values of 5% (grinding teeth) and 10% (front teeth).

Thus, we can state that in the maxillary and mandibular front teeth, the coronal portion of the tooth occupies up to 10% of the volume of tooth crown, while in the maxillary and mandibular grinding teeth, the coronal portion of the tooth occupies up to 5% of the volume of tooth crown.

4. Conclusions

Having analyzed the obtained results, we can conclude that the ratio of the volume of the coronal portion of the tooth cavity ($V_2$) to the volume of tooth crown ($V_1$) in the maxillary and mandibular front teeth constitutes up to 10%.

In the maxillary and mandibular grinding teeth, the coronal portion of the tooth occupies up to 5% of the volume of
tooth crown.

The coronal portion of the tooth occupies a small part of tooth crown, and hard tissue defect is mostly found in damaged tissue.

To estimate the extent of damage to the coronal portion of the tooth after endodontic treatment, it is recommend using the obtained data, namely, in the maxillary and mandibular front teeth, the coronal portion of the tooth occupies up to 10% of tooth crown volume, while in the maxillary and mandibular grinding teeth, the coronal portion of the tooth occupies up to 5% of tooth crown volume.

5. Prospects for further research

It is advisable to calculate the extent of teeth defects, systematize the results and develop the index for optimization of the diagnostic process in treatment of dental hard tissue defects.

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