Research Article

The Method of Diagnosis and Systematization Defects of Dental Hard Tissues

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Abstract

In the problem of solving diagnosis and treatment of hard tissue defects, a significant role is played by the choice of tactics for dental treatment of tooth decay. This work aimed at studying the problem of diagnosis and systematization of hard tissues defects, that will contribute to the objectification of diagnostic and therapeutic approaches in dental treatment of patients with this disease. The objective of the research was to develop an anatomical and functional systematization for differentiated evaluation of tooth defects, as a basis for the application of differentiated diagnostic and therapeutic approaches to dental treatment of hard tissue defects.

Materials and methods. For differential assessment of the extent of tooth defects and precise estimation of the strength of the composition "tooth-restoration", we conducted mechanical and mathematical modeling of contact interaction of restoration with dental tissues. We conducted anthropometric studies of all types of cavities of different groups of teeth as well.

Results. As a result of the study, there was proposed the systematization of hard tissues defects – location of defects, occlusive load, extent of defects/depth of decay. The algorithm for choosing the method of treating hard tissue defects that is based on the systematization of location of defects, occlusive load, extent of defects/depth of decay and may serve as a selection criterion for the treatment of such pathologies was offered.

Conclusions. The proposed systematization filled the obvious gap in academic ideas of hard tissue defects, suggested the prospect of reaching a consensus on differentiated diagnostic and therapeutic approaches in treatment of patients with this disease building the methodological "bridge of continuity" between therapeutic and orthopedic dentistry in the field of hard tissue defect treatment.

Keywords

systematization; dental hard tissue defect; diagnostics; restoration; treatment choice algorithm

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Problem statement and analysis of the latest research

Since the complications arising after various types of restorations are often caused by mistakes made by doctors at the stage of choosing a treatment method, the problem of choosing a method for treating hard tissue defects requires a thorough study and development of new approaches in accordance with the principles of evidence-based medicine [1].

When choosing the method of restoring the damaged crown of the tooth and making the diagnosis, one can consider the index of destruction of the occlusal surface of the teeth (IDOST) for Class I and Class II carious lesions according to G.V. Black proposed by Milikevich (1984). To date, the determination of the degree of the destruction of the occlusal surface of the tooth is one of the most important factors in choosing a treatment method (fillings, inlays or artificial crown). This index is used today in the post-Soviet countries for the diagnosis and choice of a method for treating dental hard tissues defects [2]. The global dental community relies on other indicators: “intercuspal distance”, Site-Stage (SI/STA) Classification System [3].

At the current stage of dentistry development, the dynamic growth of new knowledge, technologies and materials has significantly changed the methods of treating dental hard tissues defects, i.e. the absence of a clear, understandable and accessible systematization of hard tissue defects formed a methodological gap in the modern chain of treating such dental hard tissue defects [4].

Based on the meta-analysis of literature, it was concluded that complications arising after various types of restorations are often associated with mistakes made by doctors at the stage of choosing a treatment method. Thus, the problem of choosing a method for treating hard tissue defects requires a thorough study and development of new approaches in accordance with the principles of evidence-based medicine.

The objective of the research was to develop an anatomical and functional systematization for differentiated evaluation of tooth defects, as a basis for the application of differentiated diagnostic and therapeutic approaches to dental treatment of hard tissue defects.
1. Materials and Methods

For differential assessment of the extent of tooth defects and precise estimation of the strength of the composition "tooth-restoration", we conducted mechanical and mathematical modeling of contact interaction of restoration with dental tissues. We conducted anthropometric studies using methodology proposed by us [5]. Anthropometric study of all types of cavities of different groups of teeth was carried out as well.

2. Results and Discussion

In developing the systematization of dental hard tissue defects, we relied on the well-known prototypes of SI/STA classification proposed by Mount GJ and Hume WR (1998), and modified by Lasfargues JJ et al. (2000) [4, 6]. On the basis of conducted experimental researches, own scientific hypotheses, meta-analysis of scientific literature, clinical experience, we have developed the systematization of dental hard tissues defects.

The systematization is based on our own research and scientific hypothesis regarding the division into the groups of defects. The first division was made according to the depth of decay (DD).

We suggested that it was necessary to start with cases where the cavity was not defined; however, there was a "defect", namely demineralization, tooth discoloration, changes in the physiological form of the tooth requiring aesthetic restoration (or orthopedic treatment). These defects were denoted by "0" - 0 - the cavity was not defined (demineralization, discoloration, changes in the physiological form of the tooth). The following criteria were substantiated based on anthropometric studies that allowed us to determine the extent of defects in hard tissues of different groups of teeth. We marked these defects as 1, 2, 3, 4, where 1 - enamel lesion and initial dentin lesion, depth of the cavity within the outer third of the dentin; 2 - moderate dentin lesion, depth of the cavity in the middle third of the dentin; 3 - deep dentin lesion, depth of the cavity within the pulpar dentin; 4 - teeth after endodontic treatment (using anthropometric studies, we determined that in the anterior teeth of the upper and lower jaws, the crown part of the tooth cavity occupied up to 10% of the tooth crown, while in the chewing teeth of the upper and lower jaws, the crown part of the tooth cavity occupied up to 5% of the tooth crown [7]).

To describe the depth of the location of the cavity margin line towards the gingival level, we used the index, the value of which was equal to the distance (expressed as an integer in millimeters) from the level of the epithelial attachment to the deepest point of the cavity margin line. Diagnostics was carried out using a periodontal probe; modern X-ray methods of examination can be used, if necessary. If the bottom of the cavity was located supragingivally, we put the "+" sign in front of the index; if the bottom of the cavity was located subgingivally, we put the "-" sign in front of the index; if the bottom of the cavity was located at the level of the epithelial attachment, we used the "0" index. The defect of hard tissue was denoted by "C". Thus, we proposed the following systematization: C^+3 - the margin line 3 mm or more above the level of the epithelial attachment; C^+2 - the margin line 2 mm or more above the level of the epithelial attachment; C^+1 - the margin line 1 mm or more above the level of the epithelial attachment; C^0 - the margin line at the epithelial attachment level; C^-1 - the margin line 1 mm under the level of the epithelial attachment; C^-2 - the margin line 2 mm under the level of the epithelial attachment; C^-3 the margin line 3 mm or more under the level of the epithelial attachment [8].

The next division was made according to several parameters:

- **the extent of defects** in hard tissues of different tooth groups. Anthropometric studies allowed us to determine the extent of defects in hard tissues of different groups of teeth and to calculate the volumetric index of the cavity (VIC) for different types of cavities. We proposed to group the cavities by the following criteria: 1 - the VIC up to 20%, 2 - the VIC up to 20-35%, 3 - the VIC up to 35-60%, 4 – the VIC >60%. The results of mechanical and mathematical modeling of the contact interaction of restoration with dental tissues, where the linear index of tooth decay was calculated were considered. In case of photopolymer restoration, the wall thickness must be not less 17.5% of the diameter of the dental crown (we rounded off this value to 20%).

- **occlusion load** can be: insignificant, joint load with dental supporting tissues, more occlusal load than that of dental supporting tissues, the main occlusal load.

- **location of defects**: in particular, anatomical features (an important role of significant loss of enamel from the vestibular side in the incisors and canines, the importance of supporting cusps and marginal ridgets in molars and premolars).

Therefore, all the defects were divided into 4 groups:

- **Group 1** - defects with a loss of hard tissue volume up to 20%. In this case, the restoration has an insignificant occlusion load.

- **Group 2** - defects with a loss of hard tissue volume from 20% to 35% and the wall thickness of at least 20% of the diameter of the dental crown. In this case, the restoration has a joint occlusive load with dental supporting tissues.

- **Group 3** - defects with a loss of hard tissue volume from 35% to 60%, and the wall thickness of <20% of the diameter of the dental crown. In this case, the restoration has more occlusive load than dental supporting tissues.
Table 1. Systematization “Location of Defects, Occlusive Load, Extent of Defects/ Depth of Decay”

| # | Location of defects (L), occlusive load (O), extent of defects (E) (LOE) | Depth of decay (DD) |
|---|---|---|
| 0 | - | the cavity is not defined (demineralization, discoloration, changes in the physiological form of the tooth) |
| 1 | defects in the natural fossa and tissue; unilateral and bilateral defects on the incisors and canines up to a half length of the incisal edge with the preserved vestibular surface and the optimal dentin amount; defects of the cervical zone of all groups of teeth and free immediate access to them. | enamel lesion and initial dentin lesion, depth of the cavity within the outer third of the dentin |
| 2 | defects of type O on the molars and premolars with a preserved wall of not less than 20% of the diameter of the dental crown; defects of type OM (OD) and MOD on the molars and premolars without any lesions of the supporting cusps and the wall thickness of at least 20% of the diameter of the dental crown; defects on the incisors and canines with a lesion of the vestibular surface to one third. | moderate dentin lesion, depth of the cavity in the middle third of the dentin |
| 3 | defects of type O with the wall thickness of less than 20% of the diameter of the dental crown; defects of types OM (OD), MOD with a lesion of one supporting cusp in the molars; defects of types OM (OD), MOD in the premolars and molars with the preservation of wall thicknesses less than 20% of the diameter of the dental crown of the tooth; defects of incisor hard tissues with a lesion of one third to a half a length of the incisal edge; defects of canine hard tissue with a lesion of the vestibular tooth surface up to half crown width; horizontal tooth lesion up to 1/3 of dental crown height; | deep dentin lesion, depth of the cavity within the pulpar dentin |
| 4 | defects of types OM (OD), MOD in premolar hard tissues with a lesion of one cusp; defects of types OM (OD), MOD in molar hard tissues with a lesion of two and more cusps; defects of incisor hard tissues with a lesion of the insical edge more than 1/2 its width; defects of canine hard tissues with a lesion of more than 1/2 crown width; horizontal tooth lesion of 1/2 and more crown height; | teeth after endodontic treatment |

- Group 4 - defects with a loss of hard tissue volume of >60%. In this case, the restoration has a major occlusal load.

Thus, Table 1 presents 2 divisions that form our systematization.

We called our systematization LOE/DD. We propose to write it in the form of a fraction, where the numerator indicates the location of defects - LOE, and the denominator indicates the depth of decay - DD. For example: 1/0, 1/1, 1/2, 1/3, 1/4, 2/0, etc. To systematize all types of cavities localized in the cervical margin of a tooth, we used the systemization being previously described by us, where the numerator indicated the level of the cervical location of the cavity. If the cavity had marginal decay of two or more sides - we chose the deepest cavity for our classification. For example: 2x1/3, 3x1/4 etc.

According to our research, we proposed an algorithm for choosing a method for treating dental hard tissue defects, based on the systematization we proposed (Table 2).

In the available medical literature, we did not find any works devoted to the questions of clear systematization of defects of hard dental tissues. At the present stage of the development of dentistry, the dynamic growth of new knowledge, technologies and materials significantly changed the methods of treating defects of dental hard tissues [9]. In clinical cases where the cavity is located subdingerally, the "Cervical Margin Relocation" (CMR) can be used. During the period of dentistry development, various CMR techniques have been developed and studied gaining popularity among dental practitioners; however, there is no clear classification of gingival defects [3, 10, 11, 12, 13].

The importance of dental restoration using fiber posts is being discussed as well. After endodontic treatment of teeth, it is recommended to use a fiber post, as there is a greater loss of dental tissue, i.e. the decisive factor in choosing the method of treatment is the amount of lost hard tissue [3, 14, 15, 16, 17]. In the SI/STA classification system, there is no clear distinction between isolated carious cavities, located on one tooth
Table 2. Algorithm for choosing a method of treatment of hard dental tissue defects

| Method of treatment          | Systematization LOE/DD |
|-----------------------------|------------------------|
| Direct restoration          | Defects 1/0, 1/1, 1/2, 1/3, 1/4; Defects 2/0, 2/1, 2/2, 2/3, 2/4; Defects 3/0, 3/1, 3/2 |
| Indirect restoration        | Defects 3/3, 3/4       |
| Artificial aesthetic crowns | Defects 4/3, 4/4**     |

Notes:
* the tactics of treating patients with 4/0 defects depended on the etiology and depth of the change in the tooth color. Such teeth are currently treated by external or internal bleaching or by less conventional methods: indirect restoration and artificial crowns.
** the tactics of treating patients with 4/4 defects: to restore the size of tooth stump, a fiber post should be used.

The choice between direct and indirect restoration is complicated by the fact that it does not depend on the objective factors. It depends on the dentist’s knowledge, habits, preferences and stereotypes concerning the treatment of such pathologies; the patient’s consent, financial capabilities and other factors that have nothing to do with the methods of evidence-based medicine, i.d. the absence of a clear systematization of hard tissue defects formed a methodological gap in treatment of this pathology.

3. Conclusions

In our opinion, the proposed systematization filled the obvious gap in academic ideas of hard tissue defects, suggested the prospect of reaching a consensus on differentiated diagnostic and therapeutic approaches in treatment of patients with this disease building the methodological "bridge of continuity" between therapeutic and orthopedic dentistry in the field of hard tissue defect treatment. The suitability of this systematization for objectification and impartiality of the comparison of published results of treating gingival defects in hard dental tissues is equally important. The algorithm we developed for choosing a method for treating defects of hard dental tissues based on the proposed systematization LOE/DD, it is important to treat patients with this pathology and evaluate the correctness of choosing a method for treating defects of hard dental tissues.

5. Conclusions

In conclusion, each PD center has to do a map of the most common causes of peritonitis, as well as their sensitivity to antibiotics. This is important due to the adaptation of therapeutic protocols for treatment of CAPD-related peritonitis for each center specifically. However, the rare causes of peritonitis should not be ignored, especially those which can lead to increased morbidity and mortality in a certain group of patients.

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