Introduction

Due to the fact that the complications that arise after various types of restoration are often because of mistakes that doctors allow at the stage of choosing a treatment method, the problem of choosing a method for treating hard tissue defects (cavities) requires a thorough study and development of new approaches in accordance with the principles of evidence-based medicine [1-3].

Assistance in choosing the method of restoring the damaged crown of the tooth and setting the diagnosis can provide proposed by Mileikevich (1984) the index of the occlusal tooth surface destruction for Class I and II by Black. To date, determining the degree of destruction of the occlusal surface of the tooth is one of the most important factors in selecting treatment (fillings, onlay or crowns). This index is also used today in the "post-Soviet countries" for the diagnosis and the choice of a method for treating hard tissues defects in teeth [4]. The world dental community relies on other indicators: «intercuspal distance», SI/STA [5].

At the current stage of dentistry development, the dynamic growth of new knowledge, technologies and materials has significantly changed the methods of treating defects hard tissues of teeth. That lack of a clear, understandable and accessible classification of hard tissue defects forms a methodological gap in the modern chain of treatment for such defects of hard tissues [6].

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

The objective of the study – to develop anatomical and functional classification for differentiated evaluation of teeth defects, as a basis for the application of differentiated diagnostic and therapeutic approaches in dental treatment of hard tissue defects.

Methods

For differential estimation of defects in teeth and for a precise assessment of the strength of the composition "tooth-restoration", we conducted a mechanic-mathematical modeling of contact interaction of restoration with tooth tissues. We also conducted anthropometric studies using our proposed methodology [7]. We conducted anthropometric studies cavities all kinds and different groups of teeth.

Results of the research and their discussion

In developing cavity classification, we relied on the classification known prototypes cavities SI/STA, that the proposed by G.J. Mount i W.R. Hume (1998), a J.-J. Lasfargues and co-authors (2000) modified it [6, 8]. On the basis of conducted experimental researches, own scientific hypotheses, meta-analysis of scientific literature, based on clinical experience, we have developed systematization of hard tissues defects of the teeth.

Into the basis of developing classification we put our own research and our own scientific hypothesis on the distribution of defect groups. The first division of the defects we have conducted in depth lesions: depth of destruction (DD).

We suggest that it is necessary to start with cases where the cavity is not defined, but is a "defect": demineralization, tooth discoloration, changes in the anatomical form of the tooth that require aesthetic restoration (or orthopedic treatment).

These cavities denote "0": 0 – the cavity is not determined (demineralization, discolorite, changes in the anatomical shape of the tooth). We have substantiated the following criteria based on anthropometric studies that allowed us to determine the volume of defects of hard tissues of different groups of teeth.

We marked these defects as "1, 2, 3, 4": 1 – defeat of enamel and initial defeat of dentin, cavity depth within the outer 1/3 dentin; 2 – moderate defeat of dentin, depth of cavity in the middle third of dentin; 3 – deep dentin damage, depth of the cavity within the circle of the pulp dentin, 4 – teeth after endodontic treatment (By anthropometric studies, we determined that in the frontal group of teeth of the upper and lower jaw, the crown part of the tooth cavity occupies up to 10% of the crown of the tooth, and in the chewing group of teeth of the upper and lower jaw, the crown part of the tooth cavity occupies up to 5% of the crown of the tooth and in the chewing group of teeth of the upper and lower jaw, the crown part of the tooth cavity occupies up to 5% of the crown of the tooth [9]).

To describe the depth of the location of the gums edge of the cavity relative to the level of the gums, we use the index, the value of which will be equal to the distance (expressed by an integer in millimeters) from the level of epithelial attachment to the deepest point of the gums edge of the cavity. Diagnosis is carried out using a periodontal probe, if necessary, it is possible to use modern X-ray methods of examination. If the bottom of the cavity is located above gums before the index of degree, we put the sign "+", if the bottom of the cavity is located under gums before the index of degree, we put the sign "-", if the bottom of the cavity at the level of epithelial attachment – an index is "0". The defect of hard tissue will be denoted as "C". Thus, we propose such a systematization: C^{+3} – near gums edge on 3 mm or more above the level of epithelial attachment; C^{+2} – near gums edge on 2 мм mm or more above the level of epithelial attachment; C^{+1} – near

gums edge on 1 mm or more above the level of epithelial attachment; C^0 – near gums edge at the epithelial attachment level; C^{-1} – near gums edge on 1 mm under the level of epithelial attachment; C^{-2} – near gums edge on 2 mm under the level of epithelial attachment; C^{-3} near gums edge on 3 mm or more under the level of epithelial attachment [8].

The next division we conducted on several parameters:

Volume of defects hard tissues of different teeth groups (Volume) Anthropometric studies have allowed us to determine the volume of defects of hard tissues of different groups of teeth and to calculate VIC (volume index of cavity) for different types of cavities. We proposed grouping cavities by criteria: 1 – VIC to 20%, 2 – 20-35%, 3 – 35-60%, 4 – VIC more than 60%. The results also included mechanical and mathematical modeling of the contact interaction of the dental restoration, where was calculated the linear index of damage of the tooth (IDT). For photopolymer restorations wall thickness should be less $h \geq 0,175D$, that is not less 17,5% from the diameter of the crown of the tooth (we have this value rounded up to 20%).

Occlusion load, that will carry the future restoration (Occlusion) can be: small, common burden of supporting tooth structure, occlusal loading more than basic tooth, the main occlusal loading.

Location of defects (Location): 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 edge crests in molars and premolars).

We proposed to divide the cavities into 4 groups (Fig. 1 A, 1 B, 1 C, 1 D): 1) Cavities with loss of hard tissue volume to 20%. Restoration in this case will carry an insignificant occlusion load.

2) Cavities with loss of hard tissue volume of teeth from 20% to 35% and the thickness of the preserved walls at least 20% of the diameter of the crown of the tooth. Restoration in this case will carry a joint occlusive load with the supporting tissues of the tooth.

3) Cavities with loss of hard tissue volume of teeth from 35% to 60%, wall thickness less than 20% of the diameter of the crown of the tooth. In this case, the restoration will carry more occlusive load than the supporting tissues of the tooth.

4) Cavities with loss of hard tissue volume of teeth more than 60%. Restoration in this case will have a major occlusal load:
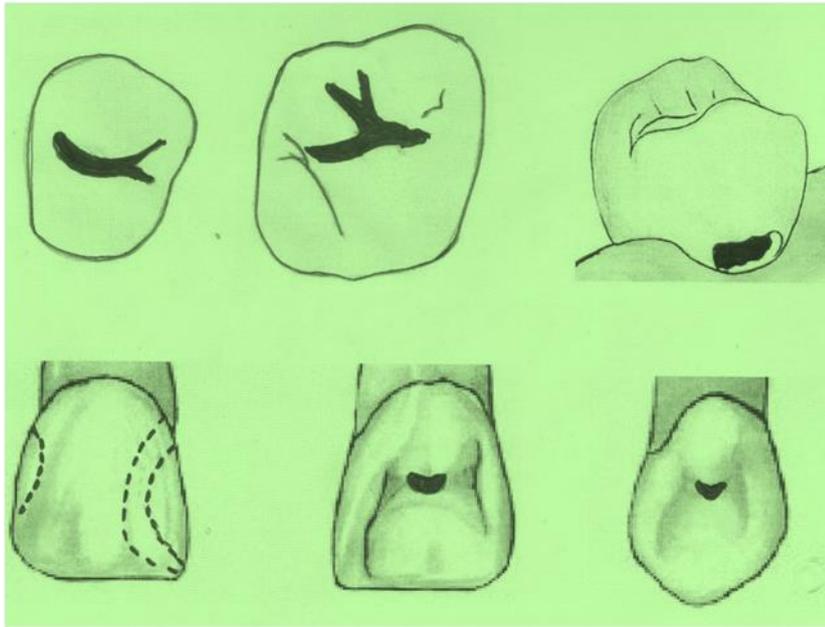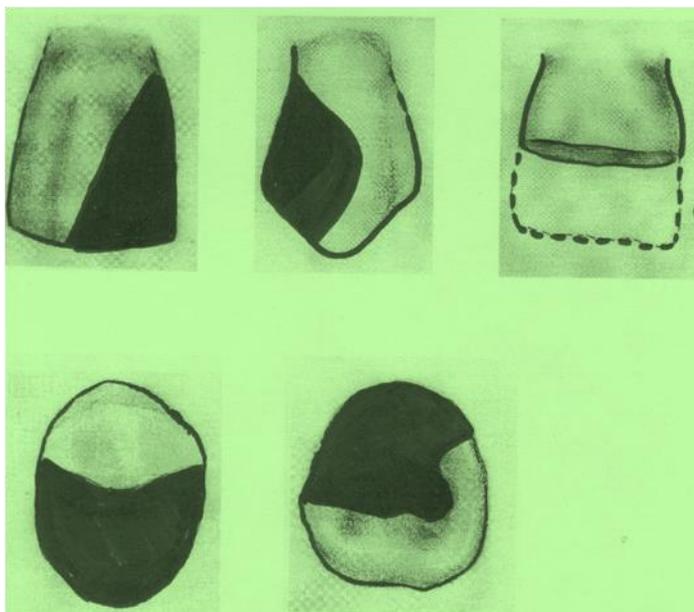
Figure 1.A. Classification LOV/DD (LOV: 1)
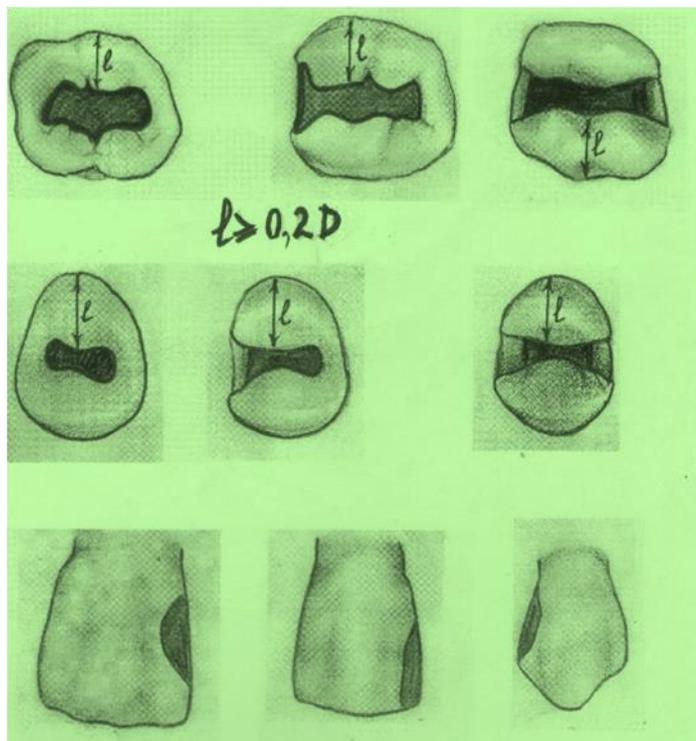
Figure 1.B. Classification LOV/DD (LOV: 2)

Figure 1.C. Classification LOV/DD (LOV: 3)

Figure 1.D. Classification LOV/DD (LOV: 4)

So we have two divisions, which are shown in Table 1, which form our proposed classification.

Table 1. Classification LOV/DD

	Location of defects (**Location**), Occlusive load (**Occlusion**), Volume of defects (**Volume**) **LOV**	Depth of destruction **DD**
0	-	the cavity is not determined (demineralization, discolorite, changes in the anatomical shape of the tooth);
1	Cavities in the area of natural pits and fissures; Cavities with one and two-sided defects on incisors and fangs up to ½ of the length of the cutting edge with the preserved vestibular surface and the optimum amount of dentin on it; Cavities cervical area of all groups of teeth and free operational access to them.	damage to the enamel and initial damage to the dentin, the depth of the cavity within the outer 1/3 dentine;
2	Cavities on molars and premolars of type O, with a preserved wall not less than 20% of the diameter of the crown of the tooth; Cavities on molars and premolars of the type OM (OD) and MOD without damage to the supporting humps and the thickness of the retained walls of not less than 20% of the diameter of the crown of the tooth; Cavities on incisors and fangs with a lesion of the vestibular surface to one third.	moderate defeat of the dentin, depth of the cavity within the middle third of the dentin;
3	Cavities type O in premolars and molars with a wall thickness of less than 20% of the diameter of the crown of the tooth; Cavities type OM (OD), MOD with a defeat of one supporting cusp in molars; Cavities type OM (OD), MOD in premolars and molars with preservation of wall thicknesses less than 20% of the diameter of the crown of the tooth;	deep defeat of dentin; the depth of the cavity within the circle of the pulp dentin.

		Cavities on incisors with a lesion of 1/3 to ½ length of the cutting edge; Cavities on incisors and fangs with lesion of the vestibular tooth surface up to 1/2 of the crown width; horizontal tooth defeat to 1/3 crown height;	
	4	Cavities on premolars of type OM (OD), MOD with a lesion of one cusp; Cavities of molars of type OM (OD), MOD with lesions of two or more cusps; Cavities on incisors with a lesion of the cutting edge more than ½ its width; Cavities on fangs with a lesion of more than ½ crown width; horizontal tooth defeat at ½ and more crown height;	teeth after endodontic treatment;

We called our classification LOV/DD. We propose to write it in the form of a fraction, where in the numerator the number indicates the location of defects LOV, and in the denominator – the depth of defeat DD. For example: 1/0, 1/1, 1/2, 1/3, 1/4, 2/0 etc.

For all types of cavities localized in the cervical margins of tooth, we have added our previously described systemization and in the record in the numerator we mark by a sign of degree the level of the cervical margins placement of the cavity. If the cavity of two or more sides has a definite near gums destruction – for the description in our classification we choose the deepest cavity. For example: $2^{+1}/3$, $3^0/4$ etc.

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

Table 2. Algorithm choice of treatment of hard tooth tissue defects

Type of treatment	Systematization LOV/DD
Direct restoration	Cavities 1/0, 1/1, 1/2, 1/3, 1/4; Cavities 2/0, 2/1, 2/2, 2/3, 2/4; Cavities 3/0, 3/1, 3/2
Indirect restoration	Cavities 3/3, 3/4 Cavities 4/1, 4/2

	Cavities 4/0*
Crowns	Cavities 4/3, 4/4**

*The tactics of treating such patients with cavities of 4/0 depend on the etiology and depth of the change in the color of the tooth. Currently, such teeth are treated by external or internal bleaching or by less conventional methods: indirect restoration and artificial crowns.

**The tactics of treating such patients with cavities of 4/4: use of a fiber post is recommended.

In the available medical literature, we did not find 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 in hard tissues of teeth [9]. In the clinical cases where the cavity is located in the gingival part, the "Cervical Margin Relocation (CMR)" can be used. During this period of development of dentistry, various CMR techniques have been developed and studied and they have become popular among practitioners, but no clear classification damages located in the gingival part of tooth has been developed [3, 10-13].

The importance of installing fiberglass pins is also discussed in this context. After endodontic treatment of teeth, the use of a fiberglass pin is recommended, as there is a greater loss of tooth tissue. That is, the decisive factor in choosing the method of treatment is the number of lost solid tissues [3, 14-17].

In the classification system SI/STA there is no clear distinction between isolated carious cavities, located on one surface of the tooth, and combined lesions that capture several surfaces. The disadvantages of this classification are the characteristic of the main chewing groups of teeth, practically not touching the frontal group [3, 18].

The choice between direct and indirect restoration is complicated by the fact that it depends not on objective factors but on: own knowledge, habits, preferences and stereotypes of the dentist concerning the treatment of such pathologies; the consent of the patient, his financial capabilities and other factors that have nothing to do with the methods of evidence-based medicine. That is, the lack of a clear systematization of defects in hard tissue teeth forms a methodological gap in the treatment of this pathology.

Conclusions.

In general, in our opinion, the proposed classification fills the obvious gap in academic representations of of hard tissue defects, opens up the prospects of finding a consensus on

differentiated diagnostic and therapeutic approaches in various clinical variants and lays the methodological " Bridge of Continuity " between therapeutic and prosthetic dentistry in the area of treatment of defects in hard tissues.

Equally important is the suitability of this classification for objectification and impartiality of the comparison of published results of the treatment of pre-defined defects in solid dental tissues. The algorithm developed by us for choosing a method for treating defects in hard tissues of teeth, based on the proposed classification of ours, can serve as a criterion for choosing the treatment of this pathology.

Prospects for further research

In the future, to check the effectiveness of the proposed algorithm for choosing a method for treating defects in hard tissues of teeth, based on the proposed classification LOV/DD, it is important to treat patients with this pathology and evaluate the correctness of choosing a method for treating defects in solid teeth.

References

1. Smithson J, Newsome P, Reaney D, Owen S. Direct or indirect restorations? Int Dent. 2011;1(1):70-80.

2. Liebenberg W. Return to the resin-modified glassionomer cement sandwich technique. J Calif Dent Assoc. 2005;(71):743-7.

3. Nikolaev AI. Sistemnyiy podhod k diagnostike i kompleksnomu lecheniyu karioznyih i prisheechnyih nekarioznyih porazheniy tverdyih tkaney zubov : kliniko-laboratornoe issledovanie [avtoreferat]. Smolensk: 2012.37 s.

4. Abolmasov NG, Abolmasov NN, Serdyukov MS. Ortopedicheskaya stomatologiya. M. : MEDpress-inform; 2018. 556 s.

5. Zarow MD, Arcangelo C, Paolone G, Paniz G, Felipe L. EndoProsthodontics – Guidelines for the clinical practice. Chicago: Quintessence Int; 2016.

6. Mount GJ, Hume WR. A new cavity classification. Aust Dent J. 1998 Jun;43(3):153-9.

7. Bulbuk OI, Hrynishak EB, Bulbuk OV, vynakhidnyky; Ivano-Frankivskyi natsionalnyi medychnyi universytet, patentovlasnyk. Sposib vyznachennia obiemu defektiv tverdykh tkanyn zubiv. Patent Ukrainy na korysnu model № 51592. 2010 lyp. 26.

8. Lasfargues JJ, Kaleka R, Louis JJ. Le concept SISTA. Un nouveau guide thrapeutique en cariologie. Real Clin. 2000;11:103–122.

9. Bulbuk O, Rozhko M., Bulbuk O. Classification of defects hard tissue located in the gingival part of any tooth. The Pharma Innovation Journal. 2017;6(6):33-35.

10. Carvalho MA, Lazari PC, Gresnigt M, Del Bel Cury AA, Magne P. Current options concerning the endodontically-treated teeth restoration with the adhesive approach. Braz Oral Res. 2018 Oct 18;32(suppl 1):e74. doi: 10.1590/1807-3107bor-2018.vol32.0074.

11. Ferrari M, Koken S, Grandini S, Ferrari Cagidiaco E, Joda T, Discepoli N. Influence of cervical margin relocation (CMR) on periodontal health: 12-month results of a controlled trial. J Dent. 2018 Feb;69:70-76. doi:10.1016/j.jdent.2017.10.008.

12. Magne P, Spreafico R. Deep margin elevation: a paradign shift, Am. J. Esthet. Dent. 2012;2:86–96.

13. Rocca GT, Rizcalla NI, Krejci I, Dietschi D. Concepts and evidence-based procedures for bonded inlays and onlays. Part II. Guide lines from cavity's preparation to final restoration, Int. J. Esthet. Dent. 2015;3:370–392.

14. Zaruba M, Gohring TN, Wegehaupt FJ, Attin T. Influence of a proximal margin elevation technique on marginal adaptation of ceramic inlays. Acta Odontol. Scand. 2013;71:317–324.

15. Paolone G, Saracinelli M, Devoto W, Putignano A. Esthetic direct restorations in endodontically treated anterior teeth. Eur J Esthet Dent. 2013;8(1):44-67

16. D'Arcangelo C., Zarow M., De Angelis F., et al. Five-year retrospective clinical study of indirect composite restorations luted with a light-cured composite in posterior teeth. Clinical Oral Investigations. 2014;18(2):615–624. doi: 10.1007/s00784-013-1001-8.

17. Sande FH, Collares K, Correa MB, Cenci MS, Demarco FF, Opdam N. Restoration survival: revisiting patients' risk factors through a systematic literature review. Oper Dent. 2016;41(S7):S7-S26. https://doi.org/10.2341/15-120-LIT

18. Wilson N, Lynch CD, Brunton PA, Hickel R, Meyer-Lueckel H, Gurgan S et al. Criteria for the replacement of restorations: Academy of Operative Dentistry European Section. Oper Dent. 2016;41 S7:S48-57. https://doi.org/10.2341/15-058-O