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Application of Affordable Nano-Hybrid Composite for Treatment of Discolorits of Tooth Hard Tissues of Various Etiologies by Direct Composite Restoration (Clinical Cases Report).

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ABSTRACT

Direct composite restoration is a big part of any dentists practice. This method of restoration of dental hard tissues has undeniable obvious advantages – low cost, access to a wide range of patients, speed of execution on the principle of "one visit – the result of", the possibility of a permanent correction of the restoration and repair. However, in clinical practice, many dentists are faced with many challenges: due primarily to the lack of clear protocols for restoration and construction of a different color interpretation of the optical properties of the composite, enamel and dentin. Our clinical experience shows undeniable advantages anatomical restoration system construction (for L. Vanini) considering physiological changes enamel elements and interpretation of its optical properties in the L*a*b* (by D. Dietschi). The combination of the above protocols can achieve an optically and aesthetically significant restoration result, clinical efficacy of which is confirmed by means of multivariate statistics, even when using low-cost "budget" composites that could have a decisive role in the provision of dental care individual social groups.

Keywords: direct composite restoration, enamel, dentine, optical properties, protocol of restoration, aesthetic of hard teeth tissue.

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INTRODUCTION

Teeth reconstruction plans have a number of problems concerning heightened requirements to aesthetics in spite of the fact that wide assortment of high-quality materials and technologies allowing to get very deserving results is present at the disposal of modern stomatological clinics [1, 2]. We while analyzing this question both in literary sources and in communicating with practicing doctors on various forums and workshops concluded that these problems mainly touch difficulties with selection of color at preliminary estimation of forthcoming restoration and disparity of work eventual results to doctor's expectations. Thus, clinical situations when teeth restorations are performed with discolorits of different etiology (improper endodontic treatment in anamnesis, hypoplasia, genotoxic discolorits, etc.), go into the first place here [3, 4]. In our opinion, it conditioned by absence of general view to nature of optical properties of tooth hard tissues [5]. According to up-to-date notions tooth's "color" is a collective notion and depends on a great number of factors, even such as seems are very far from optics as chemical composition of enamel and dentine, individual features of microstructure of tooth hard tissues, etc. Great number of researchers underlines the fact that tooth's "color" visible with human eyes is a "picture" and determined by not only a spectrum of reflection and a spectrum of absorption but a spectrum of luminescence as well [6]. While continuing the researches in this area [7, 8], we want to mention again those characteristics of tooth's hard tissues, which most doctor-stomatologists try to recreate in the course of restorations.

- tint (A, B, C, D);
- intensity (1, 2, 3, 3.5, 4 etc.);
- characterization;
- surface micro relief.

We would like to note that selection of dentine and enamel tone (A, B, C or D) always was an obstacle for practicing dentists and was one of the most difficult stages of restorations. In this connection, we consider principles of estimations of tooth optical properties proposed by the Swiss doctor Didier Dietschi and stated by him in his sensational work "Natural Layering Concept" [9, 10] as optimal. Color in the said work is interpreted on the principle of $L^*a^*b^*$, i.e. three-dimensionality (with concepts of color's characteristic of "chromatoscope", "depths", etc.), unlike many researchers who estimate a color in two-dimensional system, i.e. as a spectrum of white color. In obedience to this conception, a carrier of color (intensity) per se is dentine due to changing the optical properties in the vital process of functions. Enamel possesses properties of characterizing also depending on physiological age of tooth hard tissues. Combination of all descriptions only gives visible to eyes picture of certain color, brilliance, transparency, etc. [9-11].

MATERIAL AND METHODS

In a series of clinical researches we observed 294 restorations of different groups of teeth. There is a row of materials and methods of restoration of tooth hard tissues, based on the principle of $L^*a^*b^*$ and allowing to restore in full these parameters – *Ceram-X duo* (Dentsply), *MIRIS* (Coltene/Whaledent), *Enamel HFO* (Micerium). However, majority of the materials applied for restorations are labor intensive enough and require special training for doctors even not in medical, and rather in a plan of art, and this is the reason why their wide use during mass clinical reception is labored. Naturally, producers of stomatological materials going to meet needs of practicing stomatologists aim to create a composite, which would be simple enough in use, would maximally shorten restoration time, but would meanwhile recreate all above-stated tooth aesthetic characteristics [12]. Exactly on this account, the company *Coltene/Whaledent* became to produce additional colors further to those existing ones at market and *Brilliant New Generation* nano-composite well acquainted to dentists for using in "stream" restorations. Strictly speaking, these additional colors are not colors per se and serve for recreation of parameters of characterizing as follows:

- *White (enamel and dentin)* – for imitation of "immature" enamel, areas of demineralization, hypoplasia, i.e. during work with the young age patients.
- *Transparent* – for characterizing the age-related enamel changes, for emphasizing "delicate" areas (areas of continuous enamel).

Because both dentine and enamel are transmitters of color in this material which chromatography effect not always corresponds to aesthetic requirements of reconstruction for its intensification, we suggest to

apply the A4/C4 "offtype" tint included in the gamut of tints of *Brilliant New Generation*, and at its insufficient opaque view we used the A3,5 dentine of microhybrid of *Swiss Tec (Coltene/Whaledent)*. Before starting the discussion concerning the supposed novelties, we consider it is necessary to share our experience of clinical application of these colors at treatment of discolorits of different etiology and complete restoration of tooth crown. We applied an anatomic method of construction of restorations described in our previous works in details [4, 5].

We investigated ion exchange process in the enamel surface layer with the method of clinical evaluation of remineralization speed in enamel (CDERS test), which helps to define the level of its susceptibility to caries.

Statistical analysis was performed using a standard package Statistica 6.1. Standard software packages before their use was verified as the calculation artificially standardized data with a known result, which allowed characterizing the work of a particular program. When comparing the qualitative characteristics apply criteria Fisher exact probability and χ^2 test with Yates in editing.

As a method of multivariate statistics used cluster analysis by the method of K-means for determining the types of reactions used for the restoration of the composite.

CLINICAL CASES AND RESULTS

Patient S., 19 years, had addressed with complaints to occurrence of a cavity shown in 2.1. and 2.2. (Fig. 1). There was endodontic treatment of the indicated teeth in anamnesis. The stopping had been removed with a probe (Fig. 2). Decision on the direct restoration was made after preparation of the carious cavities (Fig. 3). We in full aware to ourselves that possibly it would be more expedient to perform orthopedic treatment in this clinical situation, however, as we had already noted more than once plenty of patients prefer presently restoration under a number of reasons, mainly economic, and we are obliged to give them an alternative variant of treatment of high enough quality.

We defined dentine of A3/D3 and enamel of A2/B2 as primary colors. "Stump kernel" was formed with dentine of A3,5 *Swiss Tec* after erection of expanding dowel, and then a celluloid matrix was imposed and wedged (Fig. 4). After that, the palatinate wall of A4/C4 enamel and the approximal wall of A3,5/B3 enamel in the precervical part and from A3/D3 in the middle third (all *Brilliant New Generation*, Fig. 5) were formed. The next stage became modeling a "dentinal body", thus, the circumpulpar dentin was recovered from A3,5/B3 dentine, and the mantle dentin was recovered from A3/D3 dentine (Fig. 6) for creation of "depth" of color, whereupon characterizing of *White* "immature" enamel (Fig. 7) was performed for recreation of "vitality" of the tooth. Then the vestibular surface was covered with A2/B2 basic enamel and *Transparent* characterizing of the cutting edge (Fig. 8) was carried out. Result of the restoration after subsequent treatment 2.2 and finish treatment of the composite shown on a Fig. 9, 10.

Patient G., 42 years, had addressed with complaints on a cosmetic defect of the frontal group of teeth of supramaxilla on the left. Objectively: 2.1 – before treated concerning caries, the restoration after clinical examination was acknowledged unsatisfactory and needing immediate replacement; 2.2 – before treated concerning complicated caries, covered with a plastic crown (Fig. 11). From data of X-ray, repeated endodontic treatment was not required. External 2.1 view after moving away the restoration and preparing the cavity is shown on fig. 12. Separate restoration of every cavity using methods described in the previous case (Fig. 13-16) was performed after application of adhesive system (*One Coat, Coltene/Whaledent*), matrix imposition and wedging. The crown from 2.2 was removed after completion of restoration 2.1 (Fig. 17) and direct restoration was carried out at the instance of the patient. In this situation, we modified our tactic a little. "Stump kernel" made from A3,5 *Swiss Tec* dentine (Fig. 18) was formed after erection of expanding dowel, and "dentinal body" – A3/D3 circumpulpar dentine and A2/B2 mantle dentin – was formed immediately after it. Then the restoration volume – a palatinate wall with appearance to the posteroapproximal surface in the upper third of A4/C4 and an approximal wall in middle- and inferoposterior third of A3/D3 – was formed (Fig. 19). The next stage was removal of palatinate matrix and setting of overhanging matrix-strip of "cap-peak" type, whereupon the adhesive system was laid repeatedly and characterizing *White* "immature" enamel was performed (Fig. 20). Then, characterizing *Transparent* cutting edge, applying basic tone to A2/B2 enamel and repeated

characterizing of bottom third of *Transparent* vestibular surface followed (Fig. 21). Result of the restoration after finish treatment is shown on Fig. 22.

Thus, we used the far enough of colorings of material according to the protocol of restoration:

1. Tooth 2.1;
 - dentins – A3,5/B3, A3/D3 (additional) and A2/B2 (basic);
 - enamels – A3/D3 (additional) and A2/B2 (basic);
 - characterizing – A3,5/B3, *White*, and *Transparent*.
2. Tooth 2.2;
 - dentins – A3,5 *Swiss Tec*, A3/D3 (additional) and A2/B2 (basic);
 - enamels – A3/D3 (additional) and A2/B2 (basic);
 - characterizing – A4/C4, *White*, and *Transparent*.

Patient V., 28 years. A 2.1 tooth before treated concerning the complicated caries using a resorcine-formalin method. Subsequent restoration dissatisfied the patient (Fig. 23 a,b). The repeated restoration (Fig. 24 a,b) was carried out in accordance with the above-described methods with colorings:

- dentin – A3,5/B3;
- enamel – A4/C4, A3,5/B3;
- characterizing – *White*, *Transparent*.

RESUME

For the period of 2012-2014, we carried out 294 restorations of different groups of teeth using *Brilliant New Generation (Coltene/Whaledent)* nanocomposite, 38 from them were carried out with use of additional *White* and *Transparent* colorings. We have already noted in our previous work the "chameleon effect" being in the material. It always is the decision factor in aesthetics of restoration renewals and shows up ability of composite "to accumulate color" of surrounding tissues within twenty-four hours after treatment. Initial situation is shown on Fig. 25 – the situation directly after the restoration realization is shown on Fig. 26, 27, and the situation after twenty-four hours is shown on Fig. 28. Certainly, this property of the material is not necessary to understand in literal sense. As a rule, correction of color takes place only within the limits of half-tones. This individual approach allows to predict the quality of restorations, including color, brightness and micro hardness and also prognoses its lifetime. All that will promote the foundational base for high-technological treatment and prevention of its complications.

DISCUSSION

Unfortunately, any printed work is always limited in volume and this is why it is not possible here to reflect all clinical situations meeting in practice of a doctor-stomatologist. CD with the doctor's tactic descriptions at different pathologies of tooth hard tissues and peculiarities of construction of restorations including corrections of color will be produced soon. Every box of *Brilliant New Generation* will be provided with this disk, and we express our hope that its content will facilitate work of practicing doctors considerably. Now we would like to note two most mass reasons of unsatisfactory results of restorations. On expression of doctors, they are so-called "white line" and "grayness of restoration". As a rule, they arise after finish treatment.

The great number of reports is present in literature concerning "white line". Foremost, reasons of such defect are inadequate preparing during preparation of cavity and presence of demineralized nonviable enamel (presence of underlied dentine is indispensable condition, and overhanging edges of enamel are inadmissible). So-called the artificial III class – leaving enamel narrow area without underlaid dentine on a cutting edge belongs here also. Creation of excessive fold of enamel – up to 2-3 mm – and nonobservance of technology of conditioning of enamel with orthophosphoric acid is on the second place. The last reason presently loses its actuality because clinicians apply self-treated adhesive systems of the VI generation now.

"Grayness of restoration" is more widespread defect even at, it would seem, correct selection of color. To our opinion, a few reasons exist here also:

- inadequate estimation of "depth" of color. Any color gotten through standard color scales included in acquisition of a composite has "depth" of 2 mm. Results give us restoration with insufficient chromatotomy effect at restoration of dentine in the middle and upper third of the tooth, where thickness is more than 2 mm always, and at use of a chosen primary color. We suggest to use the additional colors of dentine with higher intensity for prevention of this defect at forming of "dental body" (see methods of "anatomic" construction of restorations);
- failure to observe anatomic nuances of restorations (it is obvious that anatomic forms of "dental body", areas of continuous enamel, etc. should be strictly observed);
- as we suppose, absence of characterizing is the main reason, even at the correct selection of color and construction of restoration. Dentine color defined in the crown cervical part seems too saturated at structure of "dental body" and it is natural that doctors try to correct it with lighter dentine. In this case we suggest to perform characterizing of "immature" (unfully mineralized) *White* enamel and then at pathology of the IV class to perform characterizing fully mineralized enamel of cutting edge and "incisal" *Transparent* corner. After it, we applied a layer of basic enamel and in a number of cases additional characterizing of vestibular superficial mineralized *Transparent* enamel.

It is necessary to note that characterizing is especially individual procedure and its volume must be planned at estimation of color (according to alongside situated teeth) and to take into account age-related features of the restored tissues. So undoubtedly, *White* is characterizing for young age and not used for elderly patients. As a rule, *Transparent* is used for all patients during characterizing of cutting edge enamel and "incisal" corners. Additional characterizing of vestibular superficial of mineralized enamel, which depends on physiological age-related changes, is very individual.

Fig. 29 shows the dynamics of changes in the clinical status of the composite restorations in the application after 12 months of treatment presented above (group №1).

Fig. 30 shows the dynamics of changes in the clinical status of the composite restorations when applying premium-class composite is 4 times more expensive than the cost at 12 months after treatment (group №2).

Thus, analyzing the results of research obtained in the group №1, it can be argued that the decline in the quality of the restorations carried out as a vital and non-vital teeth, occurs in the first 12 months with the index factor ANOVA 1.1 for vital teeth and 1.15 for non-vital, indicating that statistical predictors of identity of the group.

Analyzing the results obtained in the group №2, we found no statistically significant reduction in the quality of restorations made vital and non-vital teeth, and ANOVA factor is 0.9, which indicates the statistical significance of the predictor as the preliminary endodontic treatment, even when working with composite of premium-class.

Cluster analysis results are presented in Fig. 31.

In a cluster, there is a difference in the average values of the variable between the groups of patients. The average value of the variable in the group №2 markedly lower than in the group №1, and the range of variation of average values of the variable has no significant values ($P \leq 0.1$) and does not affect the objectivity of the estimated parameters.

This difference between the average values of the variable can be linked to aesthetic authenticity used composite. Since immediately after the treatment in the mean values of a variable in different groups differed non-significantly, it changed not only the average values of the variables in different groups, but also the values differ significantly in the number of variations.

We after having gotten sufficient experience with *White* and *Transparent*, pay attention of practicing doctors to possibility of color corrections of earlier performed restorations from *Brilliant New Generation*

without complete replacement of the restorations in whole. In completion of our work, we would like to inform readers about a system proposed by *Doctor M. Soibelman* in 2005 [13]. This system embraces all spectrum of dental services besides the restoration quality estimation we have already described in accordance with *Ryge* criteria system and requirements of *International Organization for Quality Standardization* (Directive PN-EN No. 40049/2003). Here it is:

- unsatisfactory quality – when the result of treatment falls short of patient’s expectations;
- good quality – when the result of treatment corresponds to patient’s expectations;
- quality of "delight" – when the result of treatment considerably exceeds patient’s expectations and causes sense of moral satisfaction and professional pride for the doctor.

Fig. 1



Fig. 2



Fig. 3



Fig.4



Fig.5



Fig.6



Fig.7



Fig.8



Fig.9



Fig. 10



Fig. 11



Fig. 12



Fig. 13



Fig. 14



Fig. 15



Fig. 16



Fig. 17



Fig. 18



Fig. 19



Fig. 20



Fig. 21



Fig. 22



Fig. 23 a



Fig. 23 b



Fig. 24 a



Fig. 24 b



Fig. 25



Fig. 26

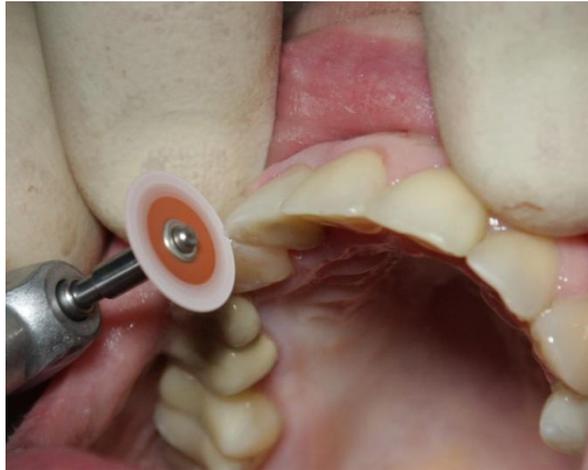


Fig. 27



Fig. 28



Fig. 29

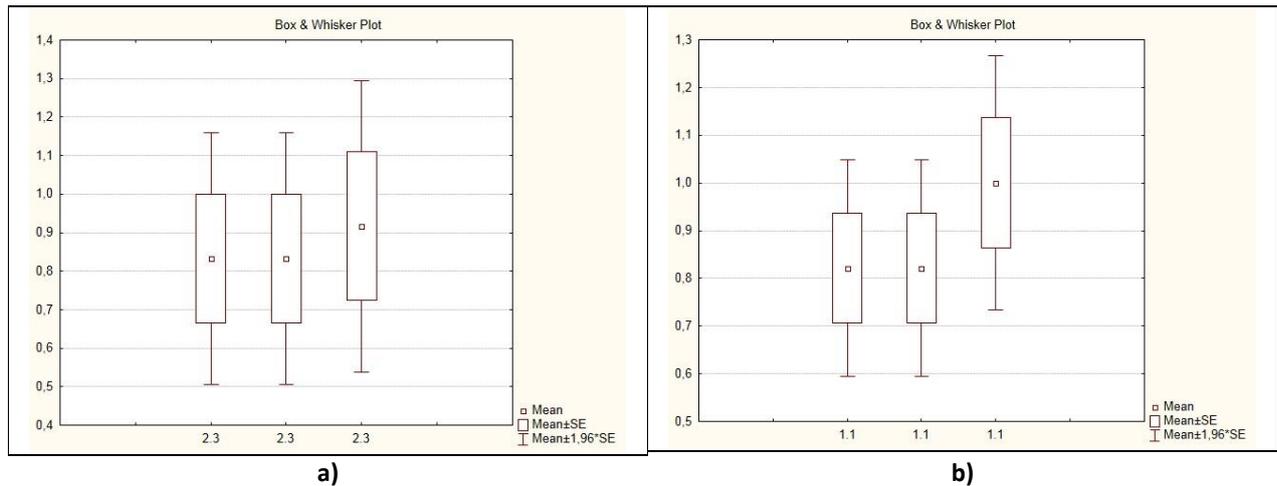


Fig. 29. The dynamics of clinical status indications restorations №1 in the group according to the correlation Friedman analysis of variance on where: a) – vital teeth; b) – devitalized teeth.

Fig.30

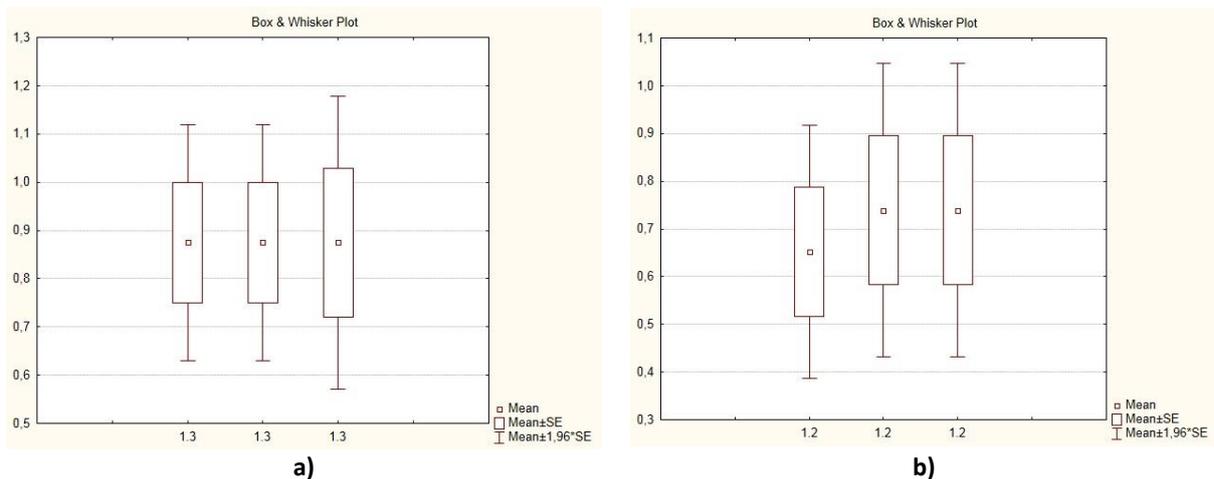


Fig. 30. The dynamics of clinical status indications restorations №2 in the group according to the correlation Friedman analysis of variance on where: a) – vital teeth; b) – devitalized teeth.

We would like to wish all our readers in their professional activity exactly of quality of "delight" and express confidence that expansion of the line of nanocomposite that is well acquainted to stomatologists will allow them not only to facilitate their labor but also considerably to come nearer to the purpose said above.

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