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**MISTAKES AND COMPLICATIONS
IN DIAGNOSIS AND TREATMENT
OF DENTAL CARIES**

Minsk BSMU 2019

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ
БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ
1-Я КАФЕДРА ТЕРАПЕВТИЧЕСКОЙ СТОМАТОЛОГИИ

Л. А. КАЗЕКО, А. Г. ДОВНАР

**ОШИБКИ И ОСЛОЖНЕНИЯ В ДИАГНОСТИКЕ
И ЛЕЧЕНИИ КАРИЕСА ЗУБОВ**

**MISTAKES AND COMPLICATIONS IN DIAGNOSIS
AND TREATMENT OF DENTAL CARIES**

Учебно-методическое пособие



Минск БГМУ 2019

УДК 616.314-002-07-08-06(075.8)-054.6

ББК 56.6я73

К14

Рекомендовано Научно-методическим советом университета в качестве учебно-методического пособия 19.12.2018 г., протокол № 4

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К14 Ошибки и осложнения в диагностике и лечении кариеса зубов = Mistakes and complications in diagnosis and treatment of dental caries : учебно-методическое пособие / Л. А. Казеко, А. Г. Довнар. – Минск : БГМУ, 2019. – 23 с.

ISBN 978-985-21-0235-3.

Изложены ошибки и осложнения, возникающие при диагностике и лечении кариеса зубов.

Предназначено для студентов 3-го курса медицинского факультета иностранных учащихся, обучающихся на английском языке.

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ISBN 978-985-21-0235-3

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FACTORS CONTRIBUTING TO MISTAKES IN DIAGNOSIS OF CARIES

Dental specialists perform a variety of procedures during diagnosis and management of dental caries. Poor execution of the latter often leads to complications. Mistakes can occur both during diagnostics, carious cavity preparation, at different stages of cavity filling and after sealing.

Conventionally, medical mistakes can be classified as tactical and technical, objective and subjective.

Tactical medical mistakes include mistakes in diagnosis.

Mistakes in diagnosis occur when the basic principles of therapeutic dental clinic organization are not observed.

The reasons leading to mistakes in the diagnosis of caries can be divided into two groups: caused by dental professionals and due to insufficient dental equipment.

The mistakes caused by the doctor are the following:

1. The doctor's ignorance of etiology, pathogenesis and clinical manifestations of caries;
2. Use of outdated methods of caries diagnosis;
3. Misinterpretation of the results of the patient examination;
4. Inability to generalize the results of the examination;
5. Negligent filling in dental medical record and other forms of medical documentation.

The mistakes due to insufficient dental equipment are:

- 1) absence of diagnostic equipment (X-ray unit, devices for electric pulp testing, etc.);
- 2) equipment of poor quality (blunt probe, poor lighting, etc.);
- 3) absence of diagnostic sets (for determination of lactobacilli and streptococci in saliva, buffer capacity of saliva, solutions for identification of oral hygiene level, etc.).

However, despite the variety of reasons for diagnostic mistakes, the basis for most medical mistakes is insufficient doctor's knowledge and inability to apply it in practice. The doctor who committed the mistake must do everything to prevent negative consequences.

MISTAKES AND COMPLICATIONS IN DIAGNOSIS OF CARIES

Mistakes and complications in diagnosis of caries:

1. Diagnostic mistakes due to insufficient identification of the patient's complaints and inadequate assessment of the pulp condition.

When a patient complains of pain from irritants, one can diagnose deep caries without taking into account the duration and nature of pain. Sealing a

tooth like this even with a medical cap can lead to the appearance of acute pain. Sometimes long-lasting pains from irritants appear, which is characteristic of chronic pulpitis. The diagnosis of pulpitis can be confirmed by electric pulp testing. However, clinical findings are usually sufficient to provide adequate treatment of such cases — pulp extirpation.

2. Mistakes in diagnosis of «hidden» caries.

Special difficulties for diagnosis are «hidden» cavities on the approximal tooth surfaces (Fig. 1). If the contact point has not yet been destroyed by caries, complaints of pain from thermal irritants are usually absent. Probing the cavity is difficult or not feasible. In this case, it is necessary to take into account indirect signs:

- change in the color of the enamel because the shadow from the carious cavity can be illuminated through the lingual, vestibular walls or marginal crest;
- complaints of discomfort between teeth during meals, difficulty in using floss when cleansing the interdental space;
- presence of inflammation of the interdental papilla (pain and bleeding when touching);
- complaints about an esthetic defect (the appearance of dark spots on densely located teeth).

In the presence of such signs it is necessary to use additional diagnostic methods (interproximal radiography, temporary selective separation of teeth, etc.).



Fig. 1. Clinical picture and intraoral radiogram revealing «hidden» carious lesions

3. Mistakes in differential diagnosis with non-carious lesions.

Difficulties in diagnosis can arise when differentiating initial multiple cervical caries and **fluorosis** opacification of the enamel, which is often localized in the cervical area of the teeth. In this case it is necessary to take into account that a pronounced cariogenic situation in the oral cavity is characteristic of caries: high caries intensity, poor oral hygiene, etc.

Mistakes in diagnosis can occur with enamel **hypoplasia** when it appears as white or pigmented spots located on the vestibular surfaces of the incisors and canines of both jaws closer to the cutting edge of the teeth. One must remember that hypoplasia is formed before the eruption of the tooth; its dimensions and color in the process of tooth development do not change. In hypoplasia stains are sharply limited on periphery from healthy enamel; they have a glassy shine and are not stained with methylene blue and other dyes.

Diffuse opacification of the enamel (defect in the transparency of the enamel) is often mistaken for caries of the enamel. A similar feature is subsurface opacification of the enamel, multiple lesions and localization of defects in the cervical area of the tooth crown. When diagnosing such lesions, it is necessary to use the method of vital staining of enamel (2 % aqueous solution of methylene blue, water solution of alizarin red), drying of the tooth surface with air. In the case of diffuse opacification, the surface of the enamel in the hypomineralization zone is smooth, shiny, and in the case of caries — matte, dull, often rough.

Mistakes in diagnostics lead to the wrong treatment plan; therefore, it is important to conduct the diagnostic steps carefully and thoroughly, and to use additional and special diagnostic tests (drying, staining, laser-induced fluorescence, electric pulp testing, quantitative light-induced fluorescence, radiographic examination, etc.).

MISTAKES AND COMPLICATIONS ARISING DURING CARIOUS CAVITY PREPARATION

In most cases, the treatment is limited to the preparation of carious cavity without taking into account the oral hygiene status of the patient, individual dietary habits, the intake of fluoride compounds. Before operative cavity treatment every dentist should identify oral hygiene indices and conduct quality control of teeth cleaning, give recommendations on the dietary regime and additional fluoride intake. Failure to comply with this rule leads to poor treatment effectiveness (emergence of new cavities and secondary caries) even with an unmistakable sealing.

Knowledge of the following possible mistakes during carious cavity preparation and filling material placement will prevent young clinician from the complications arising as the result of mistakes.

1. Insufficient cavity preparation (Fig. 2).

The basis of preparation of dental hard tissues includes removing carious tooth tissue and ensuring the retention of restorations with regard to the prevention of dental caries.

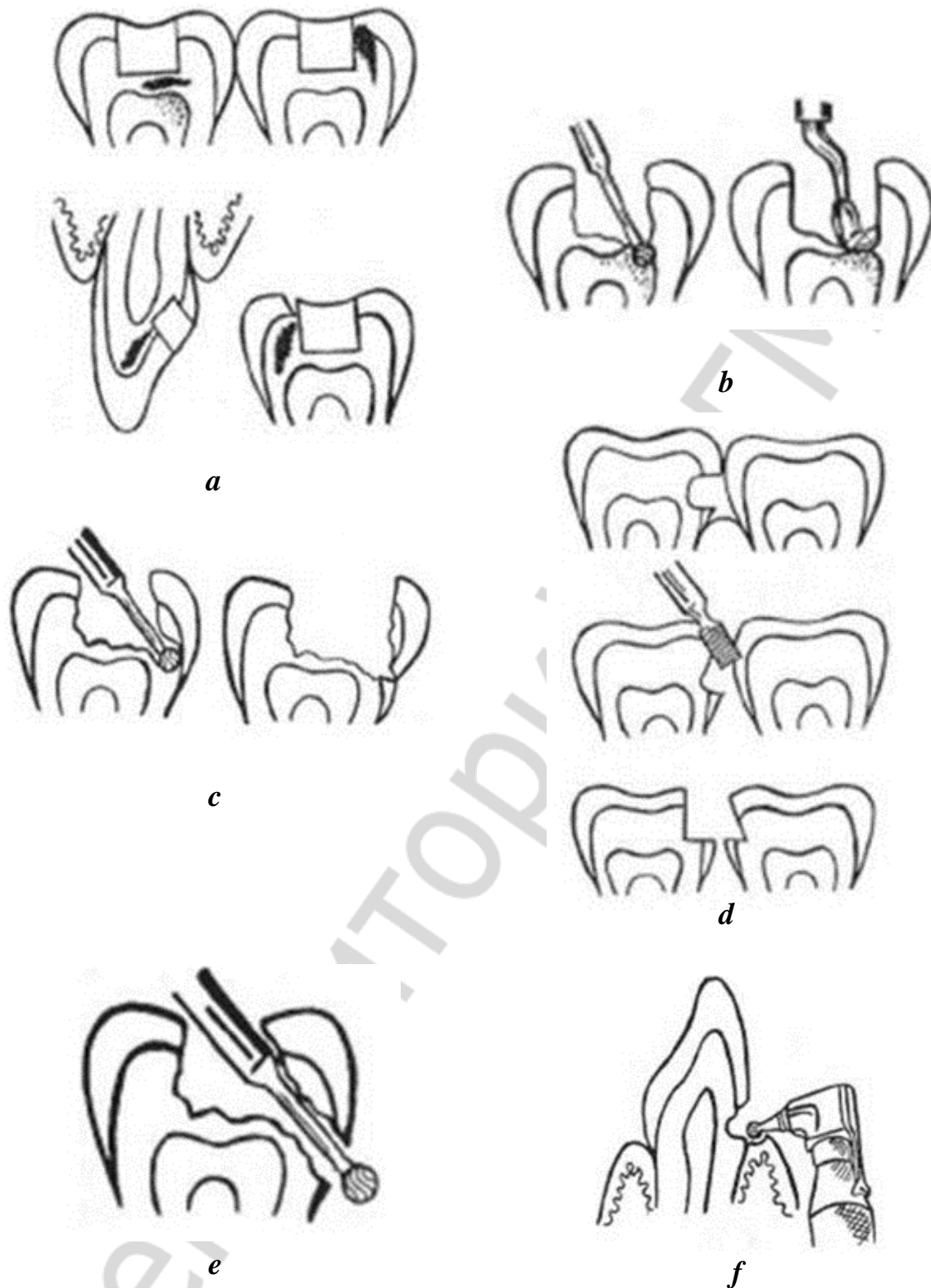


Fig. 2. Possible mistakes in cavity preparation (adopted from http://intranet.tdmu.edu.ua/data/kafedra/internal/stomat_ter/lectures_stud/en/stomat/ptn/):
a — insufficient carious cavity preparation; *b* — Perforation of the carious cavity bottom;
c — Fracture of the carious cavity wall; *d* — Injury of adjacent tooth crown by bur;
e — Perforation of the carious cavity wall; *f* — Injury of gingival margin by bur

Insufficient carious cavity preparation may lead to secondary caries, thus progressing possible development of pulpitis or the filling loss (Fig. 3). Larger preparations extended into dentin may require additional beveling to facilitate better sealing and bonding.

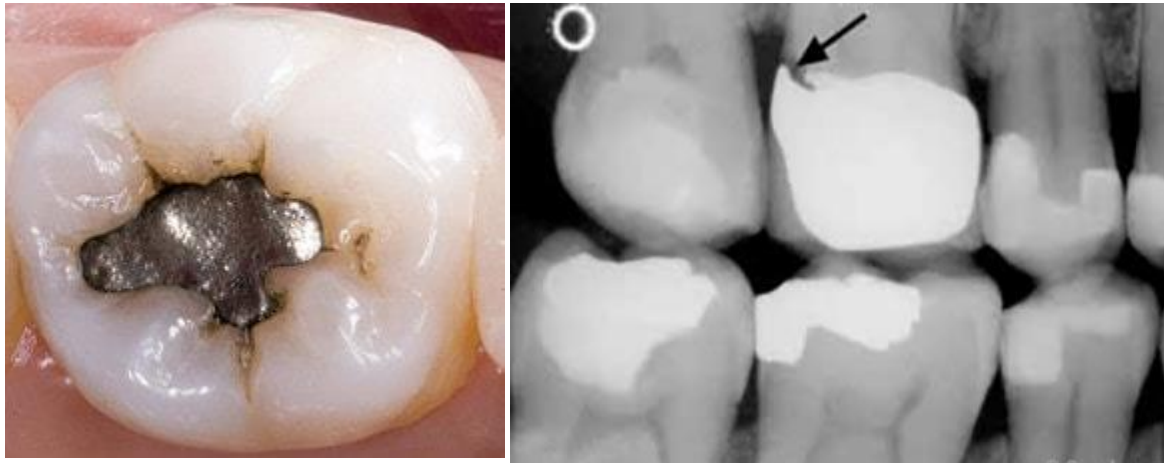


Fig. 3. Secondary caries diagnosed clinically and on the bitewing radiogram

2. Perforation of the carious cavity bottom or carious cavity wall and fracture of the carious cavity wall may happen if the clinician's hand is not properly fixed thus leading to such complications. Perforation of the carious cavity floor may happen in the case of acute deep dental caries, when the bottom is softened and a thin layer of demineralized dentin separates carious cavity from tooth cavity.

3. Injury to the adjacent tooth crown by bur may happen when visible control of operative field is not provided.

4. Injury to the gingival margin by bur may happen during the preparation of carious cavities that go deep under the gums, or if a good visibility of the operative field is not provided.

5. Wrong cavity formation. The stage of cavity formation should be carried out simultaneously with the verification of occlusal contacts (the edge of the cavity should not set on the border of the occlusal contour when forming the cavity).

6. Inadequate beveling and smoothing of enamel. Insufficient bevel of enamel can lead to deterioration of adhesion and to violation of marginal fit in future. With a small bevel on the frontal group of teeth, the esthetics of restoration will worsen (a transition from the filling material to the tooth tissue is noticeable). However, in the operative treatment of cavities on molars and premolars there are several points of view with respect to the bevel of enamel:

- on the chewing surface, a bevel is recommended at 41° (to enhance adhesion, to improve esthetics);
- enamel bevel is not recommended (R. Jordan, 1993).

In clinical practice, we dissect the bevel in patients with increased erosion of the tooth tissues, pathology of the occlusion, bruxism. If the bevel significantly weakens the walls and mounds of the tooth, beveling is not done, either.

When preparing the frontal group of teeth:

- the bevel shouldn't be exceed 2 mm;
- with fuzzy contours (better wavy);
- deep at the base of the cavity (at the entire thickness of enamel) (Fig. 4).



Fig. 4. An undulated, starburst-like bevel provides an invisible margin

Mistakes that occur during the *preparation for amalgam fillings* arise when forming the cavity:

a) The more tooth tissue is removed, the weaker the tooth becomes. Amalgam acts as an effective placeholder, but since it does not have adhesive properties, it does not help in strengthening the underlying structures of the tooth. Therefore, one should always follow the technique of minimal removal of tooth tissue.

b) When preparing the enamel, the cavity-surface angle should be made greater than 70° , close to 90° , which is optimal for amalgams, since an acute angle increases the probability of the edge breaking of amalgam.

MISTAKES AND COMPLICATIONS ARISING IN THE RESTORATION OF CARIOUS CAVITIES

Composite resins have been used for nearly 50 years, and year after year improvements have been made regarding their composition and their handling properties. However, there are problems, which have limited the use of composites. So even if composites have become one of the most preferred esthetic restorations at the present time, they say: «all that looks gold is not gold», even these restorations have their own drawbacks».

Failures that can be seen in a composite restoration are as follows:

1. Improper selection of filling material. Composites are the material used both in the anterior and posterior teeth restorations. They are indicated in Class III, IV and V lesions in the anterior teeth and in case of small to moderate Class I and II cavities. A wrong selection of filling material is made in case of poor oral hygiene as composite resins accumulate more pathogenic bacteria than amalgam or glass-ionomer cement restorations, which may lead to secondary caries due to microleakage. It is not recommended to use composites in a permanent bite if it is impossible to provide good isolation from saliva in patients with high-risk caries (multiple caries, poor oral hygiene, or if the patient does not follow proper hygiene after training and motivation).

Composite resin has less wear resistance. In patients with heavy occlusion, such as bruxism, excessive wear of the composite filling may lead to the failure of the restoration. So, pretreatment assistance of occlusion with articulating paper should be provided to guide the practitioner in the preparation design.

2. Color of composite. Determining the color of the tooth plays an important role in performing esthetic restorations. However, discrepancy between optical properties of the restoration and natural tooth tissues is quite often found in medical practice. Absence of special training in identifying shades, non-observance of the rules for choosing shade of the tooth, ignorance of the psychophysiology of visual perception can have a significant influence on the correctness of the shade selection.

The causes that lead to mistakes in determining color can be *general* and *local*.

The *general* reasons for discrepancies between tooth shades and restoration include *neglect of the color environment of the dental office*. The color of the lighting can give the teeth their color: pink, blue, greenish, this effect can be so significant that when choosing standards, mistakes are made both in lightness and in tone.

Long-term determination of shade, tedious for the doctor's visual analyzer, makes it difficult to select the shades. Identification of the color of the tooth, after a tense visual work, for example in the afternoon, leads to fatigue of the color-sensitive cells of the eye and, consequently, to an improper selection of shades of the filling material. Disregarding the *help of assistants* or *assisting unskilled assistants*, changing opinions about the color of the teeth under *the influence of the patient*, *insufficient experience of the doctor*, *age-related changes* in the visual analyzer of the dentist can also lead to mistakes in determining the tooth color.

The choice of color for illumination of the working field only by *incandescent lamps*, in the spectrum of light which contains more red wavelengths than blue and green can change the spectral composition of the light reflected

from the tooth. If the identification of hues is carried out at a *high level of illumination* (> 2400 lux), the tooth will look lighter, and the nuances of the color will not be discernible. When choosing the shades of the tooth in *low light* (< 1600 lux), the color of the tooth will be perceived to be darker.

One of *the local* causes of mistakes in the identification of tooth color is underestimation of the color background directly surrounding the tooth — the color of the hair, skin, clothing, and lips of the patient. The *nearby background* plays a significant role in the visual determination of color.

The tooth will look lighter on a dark background and, conversely, darker — on a light background. For example, the color of the same tooth is different against a background of bright lipstick or a pale border of the lips. Hypere-mic gums create a darker background, and anemic mucosa after anesthesia makes light background. Teeth appear whiter against the background of dark skin. For example, a swarthy face or a summer tan has a beneficial effect on the patients' opinion about the whiteness of their teeth. Such illusions are explained by the phenomenon of light contrast: on the border of two different surfaces the contrast of lightness sensation increases.

Non-removed plaque (light or pigmented) interferes with an objective evaluation of tooth shade. The determination of shades in a dried, not moistened tooth or after its preparation will lead to brightness of the tooth hard tissues and a temporary change in its color.

The use of *color unstable composites* can lead to the washing out of the dye from the composite, and as a consequence — to the brightening of the filling, or vice versa, to the coloration of the composite restoration with food pigments. The use of materials with fluorescence spectrum that does not coincide with that of natural tooth tissues will affect the perception of tooth color and restoration when illuminated with shortwave light, which is often used in discotheques (Fig. 5).



Fig. 5. Worn and discolored restorations in central incisors

The phenomenon of *metamerism* is also associated with the influence of the nature of the light source on color, which consists in changing the perception of color depending on the nature of the light source (daylight and artificial light)

and the composition of the object's dyes. In dentistry, a similar phenomenon is associated with the fact that the filling materials contain pigments of various nature in their composition. The more colored particles in a composite, the more diverse its reaction to different illumination, as the surface reflects those colors that are present in the illuminated rays and are not absorbed by the material. Since the pigment composition of the dentin and the composite differs, when the illumination changes, the spectra of reflected light begin to differ, as well as the color of the tooth and the seal.

The wrong choice of composite shade causing esthetically insufficient treatment result. For example, if a doctor chooses C shade instead of group A or B (from the VITA shade guide) the restoration will look gray. The grayish shade of the crown may be also explained by the unremoved plaque of the «smoker» from the oral surface of the tooth. The gray color of the restoration will be also obtained by using several color shades on a single tooth — A, B, C and D.

The discrepancy between the degree of transparency of the restoration, translucency of the natural tissues of the tooth occurs in cases of *an incorrect distribution of the opaque and enamel layers of the composite*. Grayer restorations, even with the correct shade selection, can appear because of the use of only enamel transparent layers of material through which the dark cavity of the mouth shows through. In other cases, on the contrary, there may be a loss of transparency of the restoration, which is due to the superposition of opaque layers. Using only opaque layers of material will result in loss of optical properties of natural teeth, as a result of which the illusion of a more convex tooth in the tooth row can arise. If there is insufficient application of opaque layers of the composite, a visual flattening of the crown can be observed.

A darker cervical region or a cutting edge can visually shorten the crown, and dark proximal surfaces cause the illusion of a narrow tooth.

Thus, different factors influence the objectivity of identifying the shades of tooth color by a dentist. Knowing the causes of errors in identifying the color, adherence to recommendations for the correct choice of tooth shades will allow the dentist to objectify the assessment of tooth color and significantly improve the quality of esthetic work in dentistry.

The lack of reconstruction of individual features of the tooth (eraser rings, pigmented fissures, cracks, hypoplasia spots, i. e. micro- and macroanatomy) will cause the restored tooth to become noticeable in the dental arch.

Incomplete caries necrotomy can affect the color of the structure through the transmission of pigmented tissues, and insufficient area of the bevel on the enamel will reveal the border between the filling and the tooth. *The ingress of blood and medicines* into the place of application of the filling material can also affect the color of the future restoration.

Some *metal pin structures with a weak «masking»* can shine through the layer of material.

The presence of a *pigmented rim* around the filling in the long term may be explained by a number of reasons: inadequate polishing of the filling, depressurization of the structure, poor oral hygiene, border coloring with food dyes or smoker's smear.

Clarity of the design in the long term may be due to the color instability of the material and the washing out of the pigment from the composite.

3. Lack of isolation. Composites are very sensitive to moisture contamination. Isolation is very mandatory during adhesion and bonding of composite resin to tooth structure. Failure to maintain isolation causes decreased bond strength; and ultimately, physical and mechanical properties of composite restoration also decrease. Keeping the area isolated is also a key step in contamination prevention.

4. Incorrect placement of rubber dam. Isolation can be done with rubber dam, gingival retraction cords, etc. But the most important procedure is placement of rubber dam. Appropriate contour and contacts are important for success and longevity of composite restorations. It is achieved by proper placement of rubber dam.

5. Incorrect manipulation:

5.1 Acid etching. Appropriate time for acid etching shouldn't exceed 30 seconds for enamel and 15 seconds for dentin. Enamel requires more etching time as fluoride content in enamel is higher and more resistant to acids.

5.2 Acid strength. Buonocore used 85 % phosphoric acid first. But later studies showed that higher concentration was less effective and is more likely to denude the surface; so research suggests 37 % phosphoric acid is the ideal concentration. Care should be taken before using an etchant as it evaporates during storage.

5.3 Under-etching. Failure to achieve a frosty surface could result from under-etching.

5.4 Over-etching. Over-etching can cause formation of an insoluble residue called monocalcium phosphate dehydrate, which prevents further etching and causes weak bonding. Average washing time is 10 sec. Insufficient washing leaves debris that interferes with the flow of resin. 60 sec washing with heavy water spray weakens resin-enamel bond strength as enamel rods get crushed.

6. Inadequate pulp protection. Deep composite restoration may lead to pulpal pathology and irreversible damage if not lined with a medical capping from MTA, Bioceramics, Ca(OH)₂ or similar materials. Zinc oxide eugenol based materials as insulating cappings over the medical capping are contraindicated under composites as they inhibit resin polymerization.

7. Improper placement of insulating lining. Incorrect placement of the insulating lining in deep caries can cause irritation or damage to the pulp by chemical, toxic or thermal irritants of permanent filling materials. The presence of a lining on the side walls of the carious cavity (above the enamel-dentinal

junction) worsens the marginal fit and fixation of the permanent filling material, predisposes to the emergence of secondary caries and the loss of a seal. Applying a lining to the vestibular wall of the carious cavity in the frontal teeth leads to a cosmetic defect. Opaque lining in the form of a yellow patch shines through the translucent enamel of the vestibular wall. The use of adhesive systems of the fourth and fifth generation greatly facilitates the work of the dentist, since it requires the minimum size of the insulating liner. However, in many cases a lining is necessary.

8. Improper bonding. Bonding mechanism of enamel and dentin differs. The inorganic component of enamel is 95 % and is more hydrophobic. Contrary to that, dentin is more hydrophilic as dentinal tubules have fluid flow, which makes bonding a hydrophobic resin into the dentin substrate difficult. Bond strength to all dentin surfaces is lower than to enamel. The bonding between the tooth and resin may fracture because of the following reasons:

- 1) Non-uniform application of bonding agent.
- 2) Role of evaporation
- 3) Lack of isolation.

9. Improper modeling and shaping of a filling (Fig. 6):

9.1 The absence of contact point, placement of a single filling in adjacent carious cavities will lead to inflammation of interdental papilla, thus causing pain to the patient and development of periodontal diseases. That's why during restoration of Class II by Black (proximal cavities) it is necessary to use matrix holder, matrices and wedges in order to restore contact point, and prevent these complications.

9.2 Hanging edges of a filling. Matrix system should provide appropriate contour and contact, which prevents overhangs. The matrix band should be burished to have an appropriate contour of desired shape to prevent open contact development. If it happens in the anterior teeth, it causes non-esthetic restoration, and for the posterior teeth there might be food impaction, pain and subsequent perio-problems. Matrix band should be 1 mm above the adjacent teeth. Wedges are applied in the area of gingival embrasure to provide proper contour and contact, to prevent gingival overhangs and to hold the matrix band in place.

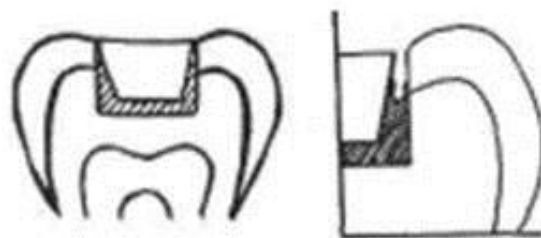
9.3 Formation of high occlusion usually happens when filling is not adjusted to the bite, when «high spots» of the material are left. The tooth in traumatic occlusion will be painful while biting (diagnostic feature) and will lead to development of apical periodontitis in future.

9.4 Voids. Leaving the voids between the layers of the filling material leads to the failure of restoration. The causes of voids are improper mixing and insertion of composite in the prepared cavity, pulling of the material during insertion, improper condensation. The void between the tooth and composite may result in recurrent caries.

Improper choice of filling material and its mixing leads to:

- cosmetic deficiencies,
- destruction and loss of the filling due to mismatch of the material strength to occlusion pressure.

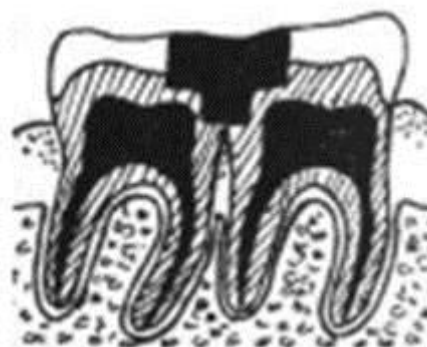
Improper placement of insulating lining



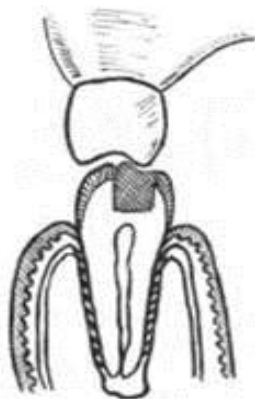
Absence of a contact point



Placement of a single filling in adjacent carious cavities



Formation of high occlusion



Hanging edges of a filling



Fig. 6. Some common mistakes in cavity restoration (adopted from http://intranet.tdmu.edu.ua/data/kafedra/internal/stomat_ter/lectures_stud/en/stomat/ptn/)

10. Improper angle and direction of light. As angle of light deviates from perpendicular direction, the penetration and intensity of light is affected and reduced. e.g. marginal ridges can block the light passage. Optimum polymerization occurs at depth of just 0.5 to 1 mm of the composite resin thickness. As the direction of composite polymerization is to the source of light, the lamp should be placed opposite to the filling.

11. Formation of oxygen-inhibited layer. Oxygen in air competes with polymerization and inhibits setting of resins. Covering the tooth with air inhibiting gel reduces oxygen inhibition.

12. Improper light intensity. Optimum curing intensity is 468 ± 20 mW/cm². The causes of decreased intensity are: 1) Age of bulb 2) Voltage 3) Sterilization of curing tips reduces light transmission. 4) Filter to increase blue light transmission. Exposure of light should be 20 or 40 sec. Any deviation in intensity range results in partially cured restoration.

13. Temperature. Light cure composites are less effective if they are cold during application. Heat accelerates polymerization but excess heat and undue pressure result in pulpal irritation and inflammation.

14. Inadequate finishing and polishing. Meticulous finishing and polishing of the filling has to be done because all rough surfaces act as niches for microorganisms. Dry polishing and finishing is detrimental as it can open dentinal margins at the dentin-restoration interface and cause pulp damage.

MISTAKES AND COMPLICATIONS ARISING AFTER CARIES TREATMENT

1. Inflammation (necrosis) of the pulp. If pulpal viability and function are to be preserved, the potentially injurious effects of cavity cutting, cavity conditioning, and cavity restoration must be assessed. The most influential variables in terms of causing pulp necrosis are the cavity's remaining dentin thickness, cavity preparation in the absence of coolant, and the selection of restorative material if the pulp tissue is exposed. Some investigations have found that the amount of intra-pulpal injury generated during cavity preparation and restoration is determined by the drill rotation speed, size, type, and shape of the cutting instrument, as well as the length of time the instrument is in contact with the dentin, the amount of pressure exerted on the handpiece, the cavity's remaining dentin thickness, restoration material temperature, and the use of cooling techniques. Other potential sources of pulp injury during cavity restoration include: conditioning of the dentin cavity walls with acid and the choice of cavity restoration materials. All aspects of restorative treatment require careful consideration in order to minimize injury and optimize pulp-dentin regeneration.

2. Secondary caries. Secondary, recurrent caries or caries adjacent to restoration occurs under existing dental restorations, such as fillings, crowns, or onlays. It may be caused by poor oral hygiene, leading to plaque accumulation around the margins of the filling, insufficient carious cavity preparation, or by development of a microscopic pathway for leakage (microleakage) past the dental restoration.

Microleakage allows acids and bacteria access to areas of the tooth that are not accessible to toothbrush bristles or other oral hygiene aids. The possibility of microleakage is a strong motivator for replacement of questionable dental restorations, as well as complete removal of old restorative materials (for example, core buildups and bases) in a tooth that will be receiving a new crown or onlay.

3. Papillitis (inflammation of an interdental papilla). As noted earlier, the absence of contact point, placement of a single filling in adjacent carious cavities, overhanging margins of dental restorations have been cited as local irritants in periodontal disease from papillitis to alveolar bone loss (Fig. 7). The patient with acute or chronic papillitis complains of pain upon biting, difficulties using dental floss. In order to avoid these mistakes one should use matrix system while filling the carious cavities of Class II.



Fig. 7. The arrow shows local gingival inflammation (papillitis) caused by loose proximal contact

4. Acute or chronic apical periodontitis. Having an insufficient cooling of the prepared tooth surface may damage odontoblasts or irreversibly change the pulp causing apical periodontitis.

The other reason for the development of apical periodontitis after the restorative treatment is the insufficiently adjusted height of the filling.

5. Displacement, fracture and loss of filling. A dental filling when properly placed is designed to withstand a great amount of pressure for a long

time. Although rare, a filling can come out of a tooth for various reasons. One of the most common is decay under a filling. An older filling can change shape and create gaps between the filling and the tooth. This allows bacteria and food by-products to get under the filling which causes tooth decay over time. When the tooth structure is destroyed, there is no solid support for the filling. This leads to loosening of the filling and eventual displacement. Another reason for filling displacement can be breakage of a supporting wall of a tooth. This is more common with silver amalgam fillings since there is no bond formation between the tooth and the filling. A tooth that has displaced a filling can be either sensitive, usually to cold, or asymptomatic.

6. Difference in color of the filling and tooth tissues. Described earlier on pages 8–10.

POSSIBLE COMPLICATIONS CAUSED BY NEGLECTING INHERENT PROPERTIES OF THE FILLING MATERIAL

1. Polymerization shrinkage and stresses due to polymerization

Composite shrinks immediately upon setting (2–3 % by volume) as matrix monomer converts to polymer. On composite shrinking stresses are invariably generated within the material at the margins. The larger the increment of composite is, the greater it shrinks. Other factors for polymerization shrinkage stress are:

1.1 C-factor which is the ratio of bonded surface to unbonded surface of the tooth cavity. High C-factor increases the polymerization shrinkage.

1.2 Cavity volume

1.3 The amount and quality of residual mineralized tooth tissue

1.4 Location of cavity margins

1.5 Bond strength of adhesive

1.6 Material composition — e. g. the bigger filler particles are the less is the shrinkage

1.7 Curing characteristics of the material

Consequences of polymerization shrinkage:

– Polymerization occurs towards the walls where composite is strongly bonded. Separation of the filling from the cavity walls may occur at their interface. Partial or total bond failure may result in loss of the restoration.

– Post-operative sensitivity.

– Marginal gap formation.

– Ingress of bacteria and secondary caries.

– Occurrence of contraction forces which are transmitted to enamel and dentin, causing cusp fracture and fracture in composite material.

2. Water sorption. Incompletely cured resin will exhibit more water sorption. It has been determined that due to water sorption there is soaking of

composite resin and the bonding strength of restoration decreases. Water sorption can be minimized by increasing filler content in the material and by providing complete polymerization.

3. Solubility. Leaching of composite components can happen in cases of incompletely cured composites.

4. Wear of composites. Each composite has different amount of abrasive wearing resistance (Fig. 8). It was shown that wear of any composite is higher than that of enamel. If tooth preparation is wide or located on a posterior (molar) tooth, the restoration is more susceptible to wear. By decreasing the proportion of filler, flowable composites are easy to adapt to small cavity preparations. However, the wear resistance of flowable composites is a clinical concern, as improved wear has been related to increased filler percentage. Highly filled microhybrid composites may have greater wear resistance to contact-supporting posterior restorations. However, in small noncontact restorations where longevity may be dictated by abrasion, flowable microfilled resins may be adequate.



Fig. 8. Wear of composite restoration

5. Microleakage. Microleakage causes post-operative sensitivity and invasion of bacteria such as *Streptococcus mutans*. Microleakage results in subsequent inflammatory changes, secondary caries and discoloration of restoration. Marginal gaps primarily occur from polymerization shrinkage on resin setting. After setting, dimensional changes occur by masticatory forces, thermal changes and water sorption of composite restoration. Hybrid and packable resin composites exhibit significantly more leakage than either the flowable or the microfilled composites.

6. Staining and discoloration. Composite resins are susceptible to various degrees of discoloration after prolonged exposure to the oral environment (Fig. 9).



Fig. 9. Staining of composite restoration

Three types of discolorations are generally described:

- 1) external discoloration due to the accumulation of plaque and surface stains (extrinsic stain);
- 2) surface or sub-surface color alteration implying superficial degradation or slight penetration and reaction of staining agents within the superficial layer of composite resins (absorption);
- 3) body, or intrinsic discoloration due to physical–chemical reactions in the deeper portion of the restoration.

To avoid composites staining it is necessary to conduct finishing and polishing of the filling correctly. Over time, if necessary, the procedure of polishing can be repeated.

7. Post-operative sensitivity (Fig. 10). If care is not taken to avoid causes of shrinkage, bonding failure and / or placement of composite restoration, post-operative sensitivity can arise. If these steps are not carried out, the gap between the restoration and tooth surfaces may form. Pressure changes in dentinal fluids, which causes irritation of the nerve processes of the pulp.

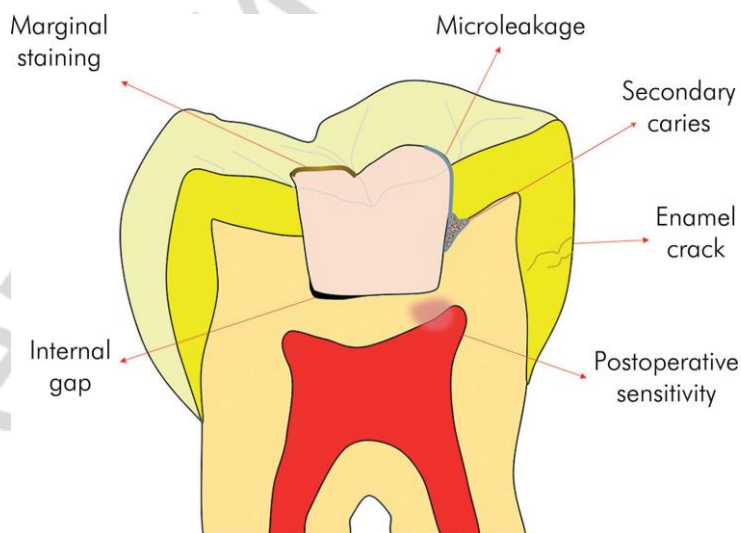


Fig. 10. Common complications in cavity restoration

Clinically composite restorations can be subjected to considerable flexural stresses. This leads to pressure changes in dentinal fluids, which are transmitted to pulp, causing postoperative sensitivity.

9. Fracture of restoration. Composite and amalgam are exposed to bulk fracture but marginal fracture is more common (Fig. 11).



Fig. 11. Fractures and cracks of different types of restorations

11. Improper storage of composite resin material:

- affect bond strength;
- premature failure.

12. Modulus of elasticity. Modulus of elasticity of composites (10.5 GPa) is less than that of enamel (33.6 GPa) and dentin (11.7 GPa), so composite forms weak bonds and tends to have micromovement under stress, which causes bond failure.

In conclusion it should be noted, that knowledge of indications and contraindications for use of different restorative materials, clear treatment plan, compliance with all technological steps of restorative treatment, adequate preparation of hard tooth tissues regarding the cavity depth and topography of the defect, differentiated choice of medical and isolation cappings, recreation of individual features of color and tooth shape, restoration of the tooth functional characteristics will allow to avoid mistakes and complications in diagnosis and treatment of dental caries.

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РЕПОЗИТОРИЙ БГМУ

Учебное издание

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**ОШИБКИ И ОСЛОЖНЕНИЯ В ДИАГНОСТИКЕ
И ЛЕЧЕНИИ КАРИЕСА ЗУБОВ**

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AND TREATMENT OF DENTAL CARIES**

Учебно-методическое пособие

На английском языке

Ответственная за выпуск Л. А. Казеко
Переводчик А. Г. Довнар
Компьютерная вёрстка А. В. Янушкевич

Подписано в печать 12.02.19. Формат 60×84/16. Бумага писчая «Хероx office».
Ризография. Гарнитура «Times».
Усл. печ. л. 1,39. Уч.-изд. л. 1,21. Тираж 40 экз. Заказ 69.

Издатель и полиграфическое исполнение: учреждение образования
«Белорусский государственный медицинский университет».
Свидетельство о государственной регистрации издателя, изготовителя,
распространителя печатных изданий № 1/187 от 18.02.2014.
Ул. Ленинградская, 6, 220006, Минск.

ISBN 978-985-21-0235-3



9 789852 102353