

Review Article

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Discoloration of A Non-Vital Tooth: Resection of Dentin

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ABSTRACT

Tooth discoloration can occur due to enamel discoloration (colored plaque, demineralization, enamel hypoplasia, dental fluorosis, cracks) and dentin discoloration due to dye infiltration (endodontic treatment with resorcinol-formaldehyde, eugenol, trauma), due to pigmentation (tetracycline syndrome) and predentin reduction (trauma, age-related changes).

This article will discuss dentin discoloration due to resorcinol infiltration after endodontic treatment with obturation of the main canal with resorcinol-formaldehyde paste. In this case, tooth discoloration occurs exclusively due to dentin infiltration with resorcinol, and the color of the enamel itself remains unchanged.

Tooth discoloration, among other methods, can also be eliminated by resection of the stained dentin, replacing it with a dentin-colored composite, and restoring the predentin surrounding the tooth cavity, within the topographic limits according to age, with a bright shade of composite of increased opacity. Dentin resection is the method of choice, and the success of this technique for eliminating discoloration is confirmed by the author's 40-year experience.

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The cause of tooth discoloration can be a change in the color of the enamel due to stained plaque, demineralization, hypoplasia, dental fluorosis, and a change in the color of the dentin due to infiltration with dyes after endodontic treatment with obturation with resorcinol-formaldehyde, eugenol, infiltration with blood decomposition products in trauma. Separately, we can distinguish masking dentin pigmentation in tetracycline syndrome and reduction of predentin in trauma or age-related changes in the topography of dental tissues⁷. For each cause of enamel discoloration, an appropriate method of eliminating this aesthetic problem is used: professional hygiene, infiltration of demineralized or fluorosed enamel, direct and indirect restoration. To eliminate dentin discoloration, internal bleaching and masking of the crown of the tooth that has changed in color with an opaque restoration are used. In each clinical case, the doctor identifies the cause of the discoloration and decides on the use of one or another treatment method, therefore each method of eliminating discoloration is the doctor's choice with the patient's consent.

Discoloration from the Perspective of Biomimetics

From the standpoint of biomimetics, when the color of a restored tooth is considered as a total combination within the topography of the optical properties of natural and artificial dental tissues, the discoloration of an endodontically treated tooth is associated only with a change in the color of the infiltrated dentin, while the optical properties of the enamel remain unchanged. Therefore, it is possible and necessary to eliminate discoloration in the case of an endodontically treated tooth only by eliminating the root cause of the pathological discoloration of the dentin, leaving the enamel intact!

Methods for Removing Dentin Discoloration

Therefore, the discoloration of the tooth crown can be masked by an opaque direct or indirect restoration or by eliminating the staining of the dentin by the method of internal bleaching. Finally, as follows from the title of the article, it is possible to simply remove the dentin infiltrated by pigments surgically, and we called this method dentin resection.

The clinical technique of resection of pathologically stained dentin was discovered by us in the 1980s during the restoration of anterior teeth after endodontic treatment using obturation with resorcinol-formaldehyde paste. The author tried to patent this method and received a decision from the All-Union Institute of Patent Science to issue a patent under application No. 4891649/14 for the "Method of filling teeth, changed in color" dated September 11, 1991 and to enter the claimed invention into the State Register of Inventions of the USSR, however, at the time of obtaining the copyright certificate of the Soviet Union, it did not exist and the patenting procedure had to be started anew under Russian legislation. Thus, the technique of eliminating discoloration of an endodontically treated tooth by resection of stained dentin remained unpatented...

However, this did not prevent the regular and systematic use of dentin resection when restoring the color of devitalized teeth with a change in color, both anterior and posterior. Unlike masking discoloration with opaque restorations, where the colour identity of the masked tooth was compromised in changing lighting compared to neighbouring teeth, or internal bleaching, where a series of procedures were required and the result was determined over years, resection of dentin infiltrated with dyes gave a rapid

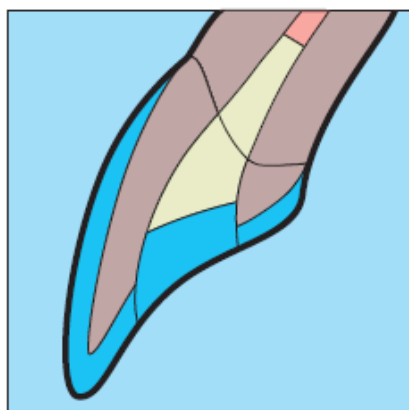
and stable aesthetic result of restoring the colour of the restored tooth.

Clinical Examples of Dentin Resection in Central Incisors

The reason for writing this article was two clinical cases, in one of which dentin resection was performed a year ago, and in the second the clinical result after dentin resection has a duration of 23 years of monitoring and service, including the renovation of the lateral teeth at the end of each 10-year service period. In the first clinical case, a 36-year-old patient was found during consultation to have a discolored upper right central incisor after endodontic treatment. This was one of the reasons for seeking dental care. The restoration of the color of tooth 11 was performed during

the first restorative session, when the anatomical shape of all upper teeth was restored within the framework of the systemic restoration of occlusion.

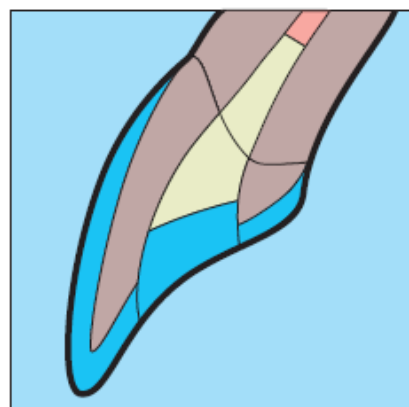
To restore the original color of the crown of tooth 11, the infiltrated dentin was resected using the technique, the stages of which are illustrated in the figures. Given the good condition of the root dentin and the obturation, an EasyPost composite post was installed to reinforce the tooth with fixation on a flowable SDR composite after adhesive preparation with Prime & Bond Universal dentin adhesive in the total etching technique (all components of the Dentsply Sirona restoration program).



Topography of an Endodontically Treated Tooth

A nonvital tooth with discoloration has stained dentin that shines through the intact translucent enamel. The root canal is filled with an obturation material, which is the determining cause of tooth discoloration due to the content of resorcinol or eugenol.

If there is also enamel discoloration - enamel hypoplasia, including fluorosis, enamel cracks due to functional overload, enamel demineralization and restored vestibular enamel defects - the vestibular enamel should be restored at the end, when the center and oral surface of the tooth crown are restored and strengthened.

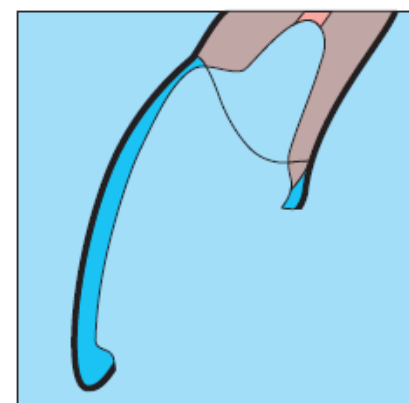


Surgical Access and Resection of Pigmented Dentin

After isolation, the oral wall and the central part of the crown of the tooth should be removed, creating access to the entire vestibular surface of the enamel from the inside.

Next, using a well-centered turbine handpiece, moving along the inner surface of the enamel, carefully remove the pigmented dentin with a medium-grit diamond head, first from the center to the cutting edge, then from the neck to the center.

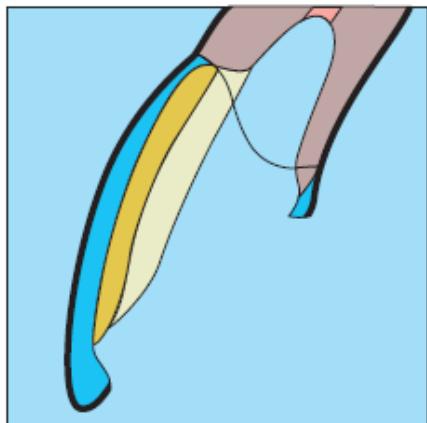
The removal of pigmented dentin can be visually monitored through the translucent enamel during resection, and between stages - through a mirror and by placing a white opaque material (cotton wool, Teflon) under the enamel.



Vestibular Enamel Support with Composite

After adhesive preparation (it's better to use the total etching technique), the vestibular enamel should be strengthened by restoring the underlying dentin with the selected opaque shade of the composite.

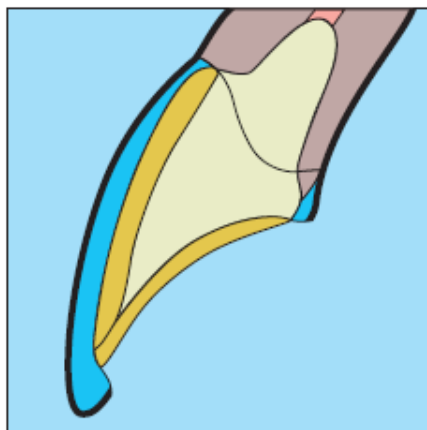
The thickness of the dentin layer should be controlled: near the neck at the level of the tooth cavity, gradually thinning in the direction of the incisal edge, and the dentin layer should end 1–2 mm before the designed incisal edge. It is necessary to give some time to reduce some of the polymerization stresses, using it to form a composite inlay or install a composite post in the root.



Formation of the Light Center of the Tooth Crown

According to our biomimetic concept⁴ of achieving the natural color of the restored tooth, the center should be filled with a white opaque shade of composite that will compensate for the absence of predentin lost due to endodontic intervention. Such a universal opaque shade is WO (White Opaq) of the nanohybrid composite Esthet-X HD (Dentsply Sirona).

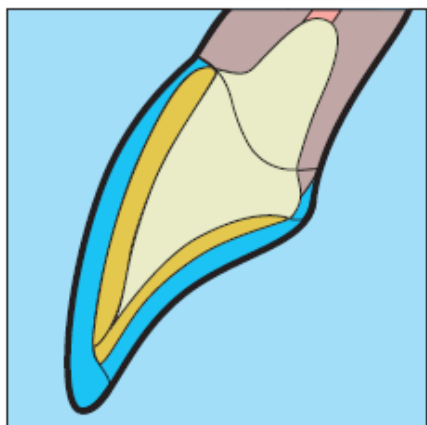
First, the obturated canal should be isolated with a flowable composite and a composite inlay should be formed or a composite post should be placed on the flowable composite alternatively. Then, the center of the crown should be filled with this shade, guided by the predentin topography for the appropriate age.



Restoration of Dentin of the Oral Surface

Next, the dentin-shaded composite should be used to restore the oral surface of the crown within the dentin-enamel junction topography, leaving a controlled space for restoration of the oral underlying and surface enamel.

The dentin is restored with a microhybrid composite, which, unlike the nanohybrid composite, is better bonded and similar in elasticity to natural dentin. We apply, bond, and polymerize two portions of the composite: the first portion, cervical, is designed for reliable attachment to the marginal enamel, the second portion continues within the dentin topography, ending 0.5–1 mm from the incisal edge.



Restoration of Oral Enamel and Incisal Edge

We restore almost all of the oral enamel with a nanohybrid composite – a body shade, and a transparent shade – the oral and vestibular parts of the incisal edge, carefully ground together.

We complete the restoration of the tooth crown by restoring the contact surfaces: first the lateral, then the medial, controlling the width of the crown with a caliper, and the height with an occlusal mirror in comparison with a symmetrical tooth.

To restore the contact surface, we also use two different composites: a body-shade microhybrid in the cervical part and a transparent nanohybrid in the part of the contact point and the corner of the incisal edge.

Upper and Lower, Anterior and Posterior Teeth, Three-Sided Bite, Occlusion Positions and Fluorescence Before Restoration



Upper and Lower, Anterior and Posterior Teeth, Three-Sided Bite, Occlusion Positions and Fluorescence Before Restoration



Photographs taken during the consultation demonstrate wear of the anterior teeth. The upper central incisors are worn with dentin exposed along the cutting edge, the lateral incisors and canines are worn within the enamel. The lower incisors have similar wear of the cutting edges. Tooth 42 has a beveled cutting edge, which may be a result of wear in the crown rotation, and the presence of a retainer on the upper anterior teeth indicates that the active period of orthodontic treatment has been completed.

The upper and lower lateral teeth have different levels of wear: the premolars and second molars are flawless for this age, the

first molars are worn, two of which are nonvital, a temporary crown with support on an implant is installed in place of tooth 25, and all four third molars are missing, possibly as a result of orthodontic treatment.

All teeth in the usual occlusion are in contact, the ratio of the first molars is slightly mesial, the midline of the upper and lower dentition is shifted to the right. The open contacts of the guiding cusps of the left Posterior teeth are noteworthy, therefore the orthodontic intervention can be considered incomplete. The bite positions in protrusion and laterotrusion show the dominant occlusion of the incisors and canines.



The fluorescence of the anterior teeth demonstrates the problem of tooth 11, i.e. the change in the color of the tooth is visible in both the visible and ultraviolet light ranges.

The small filling on the lateral surface of tooth 21 has a noticeably greater fluorescence, and this brightness in ultraviolet, unlike natural, is inherent in certain Japanese composites.

Restoration of an Upper Central Incisor with Discoloration Tooth 11 Before Restoration



The occlusal mirror image clearly shows the normal enamel color compared to tooth 21 and the concentration of staining of the crown of tooth 11 only in the dentin, including the incisal edge.

The root canal is obturated evenly to the apical narrowing, the periodontal gap without signs of a protective reaction. Class III fillings are present in the crown.

The gingival margin is tense, which is understandable given the presence of a retainer.

Resection of stained dentin, restoration of the center and oral surface using the technique of resection of pigmented coronal dentin

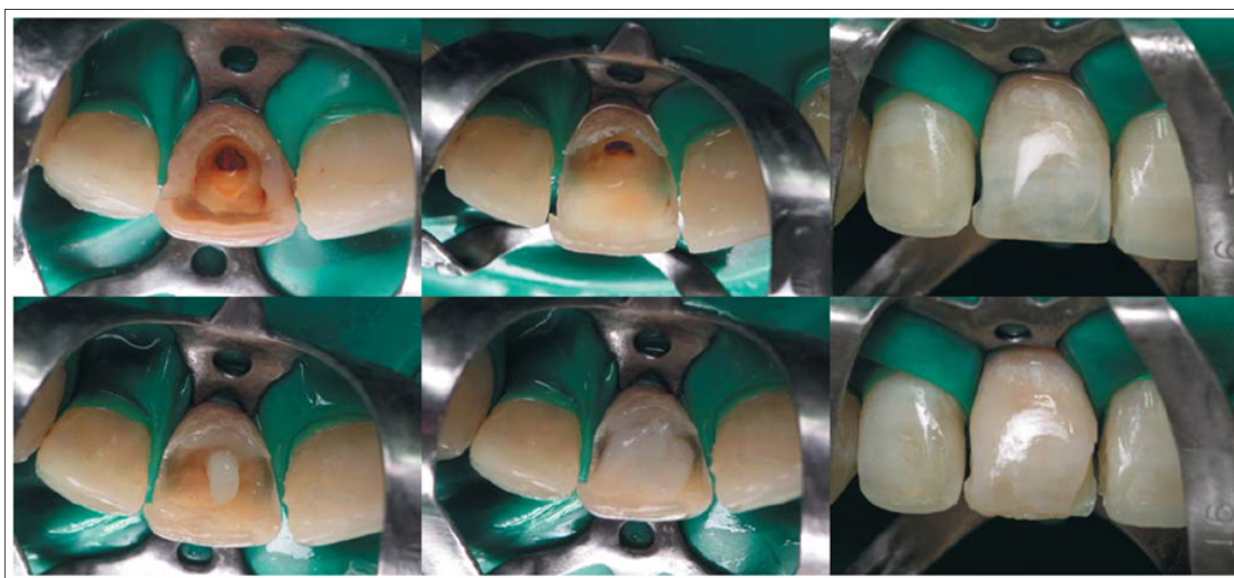
After cleaning the surface of the anterior teeth with professional paste, a rubber dam was installed and the stained tooth 11 was fixed with a butterfly clamp.

First, access was created from the oral side to the entire coronal dentin and the quality of obturation of the root canal entrance

was checked (dentin strength, density and quality of fit of the obturation material).

Then, using a diamond bur of regular grain size in a well-centered turbine tip, we removed the stained dentin from the center to the cutting edge, moving along the enamel and visually controlling the operation through the enamel. Having made sure of the strength of the enamel, both fillings were removed.

Adhesive preparation was performed, and dentin was restored over the entire vestibular enamel with a dentin shade of a microhybrid composite. The composite post is placed on a flowable composite in a prepared calibrated canal. The central part of the crown is restored with a white shade of increased opacity to compensate for the absence of predentin in the restored tooth and to ensure brightness at the level of a symmetrical vital tooth. On the oral surface, dentin is restored with a dentin shade and enamel with an enamel shade of nanohybrid composite almost to the contact surfaces.



Restoration of the Cutting Edge and Contact Surfaces

The oral surface is completed with a transparent shade of nanohybrid composite. The defects of the crown on the contact surfaces and the incisal edge are filled with vestibular body shades and transparent.

The effects of opalescence and halo should be provided by the interaction of the composite and visible light in a natural way, therefore no dyes and effect masses were used.

The contact surfaces are restored with individually contoured matrices with wedging of the teeth with transparent plastic wedges. First, the lateral contact surface of tooth 11 was restored, and

the preliminary calculations of the width of the incisors were checked with a caliper. By restoring the medial contact surfaces, we complete the restoration of all upper anterior teeth in symmetry and proportion. Therefore, the medial surface of tooth 21 was restored first and processed to achieve the calculated width, and then the medial surface of tooth 11 was restored.

The oral surface of the central incisors was formed with an olive-shaped finishing bur, preserving the protruding marginal ridges and palatal tubercles. Under the control of the occlusal mirror, the height of the crowns and the shape of the lateral and medial corners of both upper central incisors were processed with a finishing bur.



Tooth 11 after restoration



The restored central incisors have a symmetrical proportional shape (width to height ratio), positioned contact points, thin cutting edges (1.3 mm within 1 mm). The color of the nonvital and vital incisors is visually the same (white spots are dried enamel).

The radiograph shows an installed post with a bubble in the flowable composite and a clear marginal adaptation of the restoration to the tooth neck.

Restored Tooth 11 and Upper Front Teeth after Polishing



The surfaces of the composite and polished enamel of the restored teeth have a visually identical gloss. The dentist usually grinds the restored teeth, because during the grinding process, the details of the restoration shape can be changed, and the dentist is responsible for this... And the dental assistant performs the polishing, because polishing can only achieve an equivalent gloss on the surface of the composite and polished enamel (or not), and the dentist is only responsible for quality control of the polished surface of the restored teeth.

The color of the restored nonvital and vital central incisors has the same appearance along the neck, along the center of the crowns, and along the cutting edge. The discoloration of tooth 11 is detected only in the gingival part of the palatine tubercle. The color of the overdried enamel should return to its normal state after the restoration of the water balance, which can take from several hours to several weeks, depending on the structure of the given enamel. With the correction of the color of the restorations, it is worth waiting at least 4 weeks - the color can stabilize without intervention...

An occlusal mirror installed on the upper premolars demonstrates that the canines and central incisors are in the same plane in height with the premolars, and the height of the lateral incisors is less than this plane by approximately 1 mm. The crowns of the restored teeth have a symmetrical and proportional shape - in the sequential restoration from the canines to the contact between the central incisors, the "Golden Coefficient" of 1.3 was used in the ratio of the width of the crowns of the central and lateral incisors 5.

The photo of the teeth in the occlusal mirror shows the correct shape of the frontal sextant of the dental arch and the functionally active thickness of the cutting edges, which is 1.3 mm.

Optical Properties of Natural Enamel

When the procedure of resection of the coronal dentin infiltrated by pigments is performed and the non-pigmented vestibular enamel remains free, the unique optical properties of the tooth enamel can be observed...

Note that at the stage after dentin resection in both analyzed clinical cases, the tooth enamel as a translucent structure appears gray in reflected light (photo of the vestibular surface) and yellow in the light passing through it (photo in the occlusal mirror). This optical phenomenon is associated with the properties of the selective interaction of enamel with visible light .

Visible white light has a color range from violet (400 nm) to red (700 nm) through intermediate blue, cyan, green, yellow, and orange colors with a wavelength step of approximately 50 nm. Light that falls on a translucent body, which is a natural tooth with an optically complex topography (surface enamel, basal enamel, dentin-enamel junction, basal dentin, predentin, and pulp), depending on the anatomical shape, is partially absorbed, partially scattered, and partially passes deeper and deeper until completely attenuated. The difference between these three components of the interaction of visible light with dental tissues is perceived by us as the color of the tooth.

A feature of the interaction of light with a translucent body is that light of different wavelengths is completely attenuated at different depths: the light of the violet-blue part of the visible light spectrum travels the shortest distance before complete attenuation, and the light of the yellow-red part of the spectrum travels the longest distance before attenuation. Due to this feature of the interaction of sunlight with the atmosphere of the planet, we observe, for

example, a blue sky during the day, and a yellow-red sky at dawn or sunset.

Tooth enamel, with its optical properties and thickness, is opaque to violet-blue light, which allows us to see the gray color of the enamel in diffuse light, and transparent to yellow-red light, which allows us to see the yellowish color of the enamel in the occlusal mirror. These optical properties of natural enamel are the basis of the opal effect and halo effect, which dentists try to color restorations with composite and dental technicians with ceramics, although in reality it is only necessary to reproduce the topography of the tooth tissues with appropriate restorative materials, and the optical effects will occur automatically.

Color Identity of Restored Teeth

Thus, the procedure for restoring the natural color of an endodontically treated tooth through enamel preservation and resection of pigmented dentin is completed, and the result of visual identity of the vital and devitalized central incisors has been achieved. In the absence of elements of the restored tooth structure that mask pigmented dental tissues in the case of restoration with veneers or crowns, the restored vital and nonvital central incisors will change in appearance equally under different lighting conditions, while a tooth with masked discoloration loses the natural play of light and appearance...

It should be borne in mind that when checking the identity of the color of the central incisors using a spectrophotometer, for example EasyShade (VITA), there will be small differences in the data, because the spectrophotometer tests tissues to a depth of 2 mm, i.e. to the surface layers of vestibular dentin, which in the vital tooth are represented by an anisotropic structure of natural

dentin with a waveguide effect of dentinal tubules, and in the nonvital tooth - by an isotropic structure of the composite, which has such an effect of interaction with visible light does not have a spectrum.² Therefore, we recommend that you focus on visual identification under standard lighting, for example, with a D-Tec field lamp (D-Tec AB), and simply take color determination with a spectrophotometer into account.

Enamel without the Support of Dentin can Crack

The restored tooth should be examined the next day after dentin resection!

The fact is that the intensity of the chemical polymerization reaction, triggered by the light of the polymerization lamp during restoration, gradually decreases and is completely completed only after 24 hours.

The polymerization reaction is directly related to the polymerization stresses in the structure of the restored tooth. That is why after 24 hours, with the complete completion of the formation of the polymer network in the composite, the increase in stresses also ends, and the restored tooth acquires stability. Polymerization stresses can lead to the formation of a crack in the preserved vestibular enamel within 24 hours after restoration, which, if formed, usually passes through the vestibular surface of the enamel obliquely due to the torsional deformation of the structure.

The formation of a crack does not affect the strength of the restored tooth structure as a whole, but it is visible! If a crack is detected, it should be opened with a finishing bur and the enamel surface restored with a composite.

Upper and Lower, Anterior and Posterior Teeth, Three-Sided Bite, Occlusion Positions and Fluorescence After Restoration



Upper and Lower, Anterior and Posterior Teeth, Three-Sided Bite, Occlusion Positions and Fluorescence After Restoration



The condition of the upper and lower teeth is presented after the completion of systemic restoration with restoration of the anatomical form of all teeth in the free technique of direct restoration.

Systemic restoration was performed during two restoration sessions of 3 days with a break of 1 month between sessions .

The upper anterior teeth are symmetrical and proportional.

The color of the upper right central incisor, which had discoloration after endodontic treatment, does not visually differ from the color of the vital left central incisor.

The posterior teeth have a restored anatomical form, which should ensure full chewing efficiency, as well as positioning of the lower jaw relative to the upper teeth.

Implanted tooth 25 was restored with a composite on a zirconium abutment with a design for the direct restoration technique.

The lower anterior teeth, symmetrical and proportional, have restored cutting edges and contact surfaces with maximum preservation of the free surface of natural enamel. The cutting edges are restored with a thickness of 1.3 mm.

The shape of the frontal sextant of the lower dentition corresponds to the shape of the upper dentition, which ensures uniform contact between the lower and upper incisors.

In the occlusion, the displacement of the lower central line to the right is preserved, but the correct closure of the teeth in the left lateral sextants is restored.

The occlusion positions in protrusion and laterotrusion have exclusive closure of the incisors and canines.



Each composite has a certain fluorescence designed by the manufacturer, while the fluorescence of natural teeth in each person has slight differences depending on the mineralization of

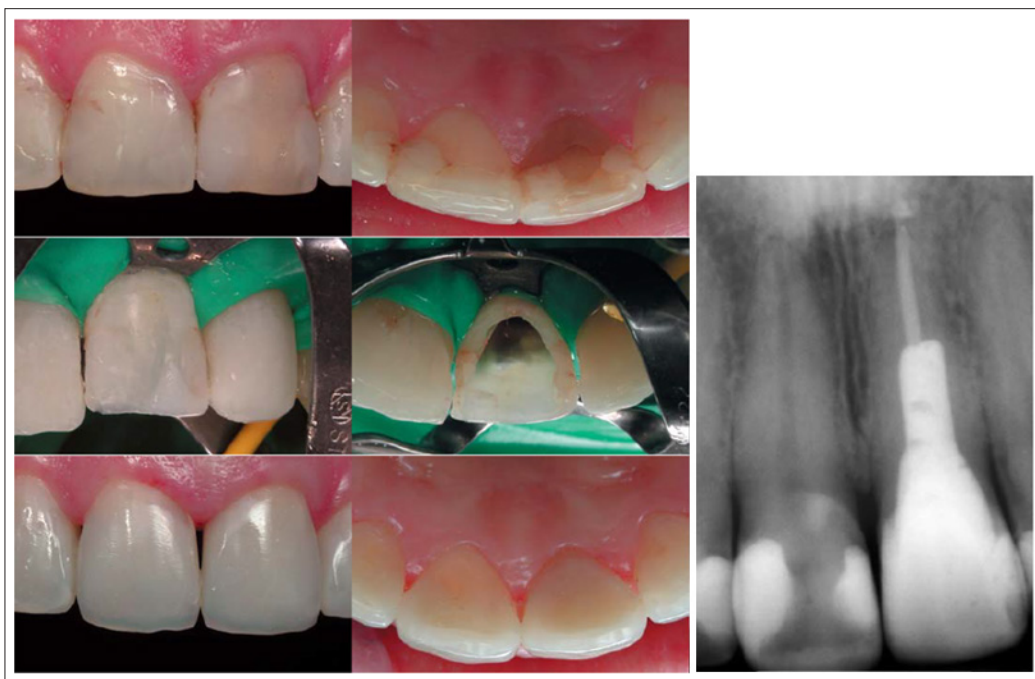
dental tissues. The fluorescence of restored teeth is acceptable if the difference between natural and artificial dental tissues is not noticeable to an outside observer.

Durability of Restored Teeth with Coronal Dentin Resection

The removal of discoloration of the left central incisor after long-term endodontic treatment was performed in 2002 using the technique of resection of infiltrated dentin. After resection, due to the absence of translucent vestibular dentin, the enamel appears gray in reflected light and yellow in the occlusal mirror due to the fact that natural enamel does not transmit the cold part of the visible light spectrum. Due to the removal of loose root dentin of tooth 21 and the thickness of the root wall less than 2 mm

(a contraindication for installing a post in the root), a root inlay was made of a bright dentin shade of the composite of increased opacity WO Esthet-X HD (Dentsply Sirona) for crown retention without any reinforcement.

The immediate result proves the effectiveness of the dentin resection technique for eliminating discoloration, because we have a visually identical color of the vital tooth 11 and the non-vital tooth 21.



After 23 years, in 2025, the appearance of the restored central incisors of the annual monitoring demonstrates the identity of the color of the vital tooth 11 and the nonvital tooth 21. The color of the nonvital tooth turned out to be more stable, because for identity

it was necessary to add an enamel shade of the composite along the neck of the vital tooth, which darkened due to changes in the topography of the predentine with age.



Conclusions

Dentin resection is effective and predictable!

The result of eliminating the discoloration of the anterior tooth by removing the stained dentin and preserving the natural enamel can be obtained immediately after the restoration is completed, which is clearly visible to both the doctor and the patient, as was shown in the first clinical case.

Dentin resection is stable and reliable!

The long-term results of the functioning of the anterior and lateral teeth in which dentin resection was performed prove the stability of the color and reliability of the design of the restored tooth with artificial crown dentin, as was shown in the second clinical case.

Of course, the durability of the restored teeth depends not only on the execution, but also on compliance with general operating recommendations [1-10].

The use of a protective mouthguard that isolates the upper and lower teeth from each other during jaw clenching as a stress response is mandatory: a night guard constantly and a day guard for the period of expected stress. Dentin resection in a devitalized stained tooth is a matter of choice for the dentist in agreement with the patient!

A conscious choice requires the dentist not only to have the idea of eliminating the root cause of discoloration, but also certain manual skills and talent for its implementation in clinical practice.

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