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ASPECTS OF LIGHT AND COLOR IN AESTHETIC DENTISTRY

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Abstract
When examining the dentition and individual teeth, a rainbow of their inherent colors is revealed - from transparent blue, grayish to various shades of white, yellow and light brown. In addition to individual colors, intact teeth have properties such as a special enamel gloss, opalescent and fluorescent effect. The teeth of the same person may differ in color depending on their group membership. Therefore, canines are usually darker (or yellowish) than incisors.

Introduction

Methods And Materials

At the same time, one of the most characteristic properties of the dental arch is preserved – symmetry - in this case, the similarity of the optical properties of the teeth located on the left and right sides of the sagittal plane.1 The color of the tooth itself, or an objective object, is determined by the structure of its tissues. Enamel has the ability to reflect the full range of colors characteristic of white surfaces. Therefore, a common shade of enamel is white 1). Enamel also has the ability to scatter rays – to reflect light in different directions, reducing its luster and color, thereby increasing the whiteness of the crown, which is typical for young people. The properties of enamel, which partially transmits and partially scatters light rays, characterize its photoconductivity 2). The pigments contained in the organic structure give dentin the property of selective reflection (the ability to reflect waves of a certain length of a larger size), and dentin forms the color of teeth 3). The inherent properties of light transmission in enamel allow light rays selectively reflected from dentin pigments and enamel-dentine compounds to pass through the enamel and be perceived by the eye as the color of teeth. At the same time, visual perception is not directly related to the spectral composition of the light reflected by the tooth surface. It depends on the surrounding factors. The visual perception of the aesthetic parameters of the tooth is greatly influenced by the surrounding background, the color scheme of the light environment, as well as light and dark, associated with rays reflected from the surface. A slight deviation in the relief of the surface being restored changes the direction of the reflected light rays, as a result of which the image formation process by the visual analyzer changes. Knowing the patterns of occurrence and manifestation of light

phenomena, you will be able to create an aesthetic restoration that corresponds to the shape, size, relief and shade of teeth natural indicators. 1. One of the factors influencing the subjective perception of color is the illumination of teeth. The (objective) color of the tooth itself can change under the influence of the intensity and composition of the light, the nature of the illumination, as well as the location of the light source and the direction of the rays. Thus, in the rays of natural sunlight, running almost parallel and evenly illuminating the surface, the perceived image of the optical properties of teeth becomes the most objective. Artificial light sources, especially closely located, cause bright illumination of the convex vestibular surface and shading of the proximal ones. As a result, the shape of the teeth affects the definition of hue, lightness and saturation due to uneven illumination of their various surfaces. The rays fall on them at different angles and are reflected accordingly, creating the illusion of uneven coloring. Thus, the proximal area looks darker than the vestibular surface. The original color is preserved as much as possible in the area where the rays pass tangentially. The macrorelief of the teeth contributes to the fact that the light directed at the surface is distributed unevenly, forming a chiaroscuro 4). The brightest areas that reflect the most light create glare. Partial shading is formed in the area of the surface illuminated by an oblique sliding beam of light. The darkest areas have their own shadows. Its own shadow, illuminated by rays reflected from neighboring objects, forms a reflection (a "colored" shadow). The formation of reflections leads to the fact that the illuminated and shaded areas of the same tooth differ not only in brightness, but also in hue. Objects of white coloring are most affected by the color of lighting, so the color of lighting strongly affects the determination of the color of teeth. The peculiarity of the reflection of the dental arch requires another study, since the color of the cervical region of the tooth can vary greatly under the influence of the color of the gums. Thus, inflammation of the mucous membrane with hyperemia will give the enamel a pink tint by staining it with its own shadows (reflections). A similar effect can be caused by lipstick staining the nails of an assistant (Fig. 1). 5). The cofadam used creates a blue or green shadow and determines the appropriate shade of the teeth or individual areas (Fig. 1). 6). The location of the tooth in the dental arch can have a significant effect on its illumination and, consequently, on optical perception (Fig. 1). 7). If the tooth is located in the oral cavity or brightly illuminated in the vestibule area, the tooth will look darker. The color of the shadow also depends on the relative position of the tooth and the surrounding tissues. When the patient is lying down, the angle of incidence (and, consequently, reflection) of the rays changes, which affects the illumination of the tooth surface and the perception of tone, lightness and saturation. The neck part of the crown looks dark, the cutting edge becomes very light.

In this case, the teeth will look shorter. The color of the lighting can give teeth their own color: pink, blue, greenish 8). The overall color background of the room is formed not only by natural and artificial lighting, but also by a combination of rays reflected from walls, curtains and other objects, so their coloring affects the perception of the color parameters of teeth 9). In addition, such an effect can be very important, therefore, mistakes are made when choosing a standard not only in the lighting, but also in the tone. Thus, clinical studies have shown that the reddish-brown blinds in the office shift the main shades of the studied teeth from group B (red-yellow) to group D (red-gray). In addition, the perception of tooth shades is influenced by the spectral composition of the rays of a particular light source 10). The lower the temperature of the light source (incandescent lamp), the stronger the yellow, orange and red rays. Teeth of the same color become brighter and more saturated. The phenomenon of metamerism is also associated with the influence of the nature of the light source on color, in this case it consists in detecting and eliminating the difference in tooth color when changing the light source. This phenomenon is due to the fact that the filling material contains pigments with different properties. The more colored particles in the composite material, the more the surface reflects the colors that are present in the irradiated light rays and are not absorbed by the mass of the material, therefore, the pigment composition of dentin and the complex is different under different lighting conditions, therefore, when the illumination changes, the spectrum of reflected light changes. the lighting starts to vary, and therefore the color of the teeth and fillings becomes different. The level of illumination has a significant effect on the perception of tooth color. Teeth look pale (discolored) in both bright and low light. The illumination of the teeth should not exceed 1500-2000 lux, since the human eye does not distinguish the nuances of color with excessive brightness of light. A higher level of illumination leads to a decrease in saturation. In conditions of insufficient lighting, the color of the teeth also loses its saturation. In low light, the (objective) color of the teeth themselves, in particular the nuances (the highest shades and shades of saturation or lightness), do not differ. The color of the teeth is determined mainly by shades of gray. This is due to a decrease in the activity of color vision receptors and an increase in the activity of perception of dark vision – achromatic (white–gray–black). In addition, in low light, the rod (the twilight vision receptor) retains sensitivity to the blue-green part of the spectrum and loses it in the orange-red (Purkinje phenomenon). The most important characteristic that generates and explains the most common errors in the visual assessment of tooth color is the intensity of visual perception under the influence of concomitant or previous stimuli. Play your part. As mentioned above, you can create shadows with reflective colors. In particular, pink

mucous membranes of the gums, lips and tongue, for example, in the gum area, cause a pink "glow" of the teeth. The same background (contrasting) will be added to them, which can emphasize several shades. The red color of the lipstick emphasizes the green and blue tones of the enamel; orange - blue . 13). This is explained by the phenomenon of simultaneous color contrast – an increase in the intensity of perception of contrasting (additional) colors if they are located side by side. The blue box enhances the intensity of the feeling of the yellow tint of the tooth, and the hyperemic gum promotes the perception of a blue-green tone in the spectrum of rays reflected from the surface of the tooth 14). In the first case, the color of the corrected tooth becomes more yellow, and in the second case it becomes more blue than its own (objective) color. Teeth look light on a dark background and, conversely, dark on a light background. For example, in anemia after anesthesia, the mucous membranes create a bright background, which affects the perception of brightness. In addition, near the boundary between the object (tooth) and the background (mucous membrane), the contrast of sensations is especially enhanced.The border strip of enamel will be darker or lighter than it actually is (depending on the background). Such illusions are explained by the phenomenon of light contrast: at the border of two surfaces of different brightness, the contrast of the feeling of brightness increases, and the teeth appear white against the background of dark skin. For example, a summer sunburn has a beneficial effect on the patient's opinion about the whiteness of teeth . 15). The perception of subtle color differences (color nuances) can be difficult due to the inability to distinguish the background from the object, since these concepts are dynamic, and vice versa. An example is the choice of a dentist based on the shade of the dentition, the patient's face, clothes and the color of individual teeth against the background of the walls of the office. Some dentists choose the basic color of the structure, taking into account only the shade of neighboring teeth. In this case, the manufactured design can create color asymmetry. The background also plays an important role in determining the contour of the tooth. The more contrasting the brightness and color of the teeth and the surrounding background, the more clearly the boundaries of the teeth are defined . Therefore, against the background of a dark oral cavity, the shape of the cutting edge is perceived more optimally than against the background of teeth of the opposite row. Depending on this, with open teeth, the contour of the incisors is evaluated more accurately. The color contrast also highlights the relief of the surface . After studying incandescent lamps and sunlight, it becomes impossible to determine the shade of teeth, which is explained by the phenomenon of constant contrast. Long continuous images can last up to 1-2 minutes, which makes it difficult to visually perceive tone, lightness and saturation. If you look at the colored

background and transfer it to the dentition, then the appearance of a so-called negative continuous image affects the determination of tooth color. The shade of the teeth is mixed with additional colors on the primary stimulus. Therefore, a preliminary study of a blue background (for example, a bathrobe) will enhance the perception of a yellowish tinge of teeth . 18). A stable image of a red stimulus (for example, the patient's clothes) acquires a bright blue-green color, which, accordingly, affects the perception of the enamel color. The appearance of positive and negative continuous images is explained by the inertia of vision, as well as fatigue of individual areas of the retina due to discoloration of the pigment that perceives the primary image. The optimal conditions for color perception are created by a gray background that does not affect reflections or perceived contrast A superficial examination without examining the tooth area can lead to misconceptions about the strength, shades of color and types of transparency of the enamel. This is due to the presence of a sensitivity threshold of the visual analyzer: the weaker the stimulus (for example, the intensity of color), the longer it takes to form a sensation. Sensitivity to the perception of tooth color may change under the influence of the activity of another analyzer system. For example, a slight taste of sourness will increase visual sensitivity. Strong stimuli (light, sound) can reduce the acuity of color perception. The assessment of the aesthetic parameters of teeth is influenced by an unfavorable environment (noise, dust). In people with an artistic personality type, color images are formed under the influence of sound, which can also affect the results of evaluating visual images (colors, shapes). The different perception of the color and size of teeth by different people may be related to the phenomenon of dominance of one eye: the dominance of vision in one eye leads to a deviation in the angle of vision, and it seems that the size of the teeth is larger or smaller. Thus, the angle of reflection of light rays, local illumination and color parameters may vary. According to the law of irradiation (the influence of color on the visual assessment of size and shape), the phenomenon of color and light contrast can affect the perception of volumetric properties, as a result of which teeth look larger against a dark background of lipstick, cofadam reports. The phenomenon of changing the size and shape of the surface depending on color and brightness leads to the fact that light areas, including restoration ones, are perceived as larger. Warm tones (yellow-orange) create the illusion of bulges - they "protrude" forward. Light tones create the same effect as warm ones, while dark tones "recede" like cold ones. As a result, the design of light and warm tones is perceived as voluminous, large and "protruding". Bluish teeth look flat and are located in the mouth. If yellowish light shades are used for the central part of the teeth, as well as for the proximal area and the most advanced cold gray–blue tones, then depending

on the volume of the structure (veneer, crown) and the phenomenon of light contrast, the teeth will look white against a background of dark skin, which means that they are perceived larger. The quality of the assessment of shades of color is influenced by the state of the receptor apparatus of the eye. Colors are perceived poorly: mainly in the blue or orange part of the spectrum, if 1, 2 or 3 color receptors are missing on the retina. Partial color blindness is known to occur in 8% of men and 1% of women. The illusion of visual perception can occur under the influence of drugs and many other drugs that affect the body. For example, nicotine, alcohol, and stimulants impair (confuse) color vision. Glaucoma (increased intraocular pressure) is also accompanied by impaired color perception. The daily biological rhythm of visual perception is characterized by a decrease in the objectivity of color assessment in the morning and evening compared with optimal color perception, which occurs after 12-14 hours. By the end of the preparation of complex teeth or by the end of the working day, the eyes will get tired and it will be difficult to distinguish the nuances of color. The color detection procedure will not be possible if you move from a brightly lit room to a dark one.The adaptation of the eyes to darkness is accompanied by a decrease in vision, therefore, the rod-shaped receptor system, which perceives black-and-white transitions, that is, gray tones, becomes more sensitive. When moving from a dark room to a light one, vision adapts within a few seconds. However, with uneven illumination of the tooth surface, color determination is difficult, since pronounced local illumination leads to the appearance of a solid image. They are present for a short time, but if the eyes are adapted to the dark and the lighting intensity is high, a bright image remains in the field of view, masking the true color of the teeth. Age-related changes in the visual analyzer significantly affect the perception of color characteristics. The eye's ability to perceive color begins to deteriorate after 30 years due to the accumulation of pigment in the lens. Active vision, provided by the movement of the eyeball, is reduced due to the limitations of the musculoskeletal system. In the absence of eye movements, the color and shape of the stimulus will cease to be perceived. As a result, the objectivity of assessing the size, shape and color of teeth decreases. An important characteristic of the visual analyzer – sensitivity (ability) to distinguish - requires professional training of specialists. In the absence of special training and calibration, it is difficult for dentists to formulate a gradation of differences by conducting a qualitative and quantitative analysis, for example, comparing the tone, lightness and saturation of teeth with the VITA PAN-3m scale. In addition, a perceptual image that reflects objective reality as much as possible and serves as a criterion for activity is formed only in the process of purposeful practical training. The lack of observation - the ability to notice details, characteristic features

– inclines a person to form a system of perceptual images, including subjective (desirable) ones. Depending on the amount of experience, interest, knowledge, objectivity or relevance (perception), a person's individual attitude to the perception of objects, in particular colors, has a significant impact on the interpretation of colors and their properties. In the manufacture of aesthetic designs, the individual perception of color by dentists, assistants and the patient himself is influenced. If a person wants to whiten his teeth, he perceives the color of his teeth as dark, yellow or gray.

To conclude: Therefore, an insufficient level of knowledge about the characteristics of tooth color in the absence of an important assessment of this situation will inevitably lead to incorrect results. The influence of various factors on the objectivity of assessing the color characteristics of teeth requires a special analysis of the working conditions of dentists, dental technicians, as well as the use of recommendations to eliminate external influences when performing aesthetic work.

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