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FACTORS AFFECTING THE VISUAL TOOTH SHADE SELECTION: A REVİEW

GÖRSEL DİŞ RENGİ SEÇİMİNİ ETKİLEYEN FAKTÖRLER: DERLEME

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Abstract

The increase in the esthetic demands of the patients, leads to various developments in the materials used in dentistry and treatment options. One of the most important steps in realizing these developments and creating the ideal esthetic perception is the right shade selection. Color harmony between teeth and restorations is an issue that is highly important for patients.

Different methods can be used in tooth shade selection: visual shade selection with tooth shade guides and shade selection with digital devices. Human eyes are very sensitive to even the smallest difference between colors; but color perception is subjective in shade selection using tooth shade guides. Various factors, such as the physician's age, gender, experience, physical mood, position of the patient's head, ambient conditions, and the light source, can affect the visual shade selection results. In this review, the factors affecting the visual tooth shade selection with tooth shade guides are explained. Due to the subjectivity of color perception, the complexity of the shade selection procedure and the problems that may occur with digital color measuring devices; it is recommended to use digital and visual shade selection methods together in dentistry.

Keywords: *Tooth color, visual shade selection, esthetic dentistry.*

Özet

Hastaların estetik taleplerindeki artış, diş hekimliğinde kullanılan materyallerde ve tedavi seçeneklerinde çeşitli gelişmelere yol açmaktadır. Bu gelişmelerin hayata geçirilmesi ve ideal estetik algıyı yaratabilmekteki en önemli basamaklardan biri, doğru renk seçimidir. Dişler ve restorasyonlar arasındaki renk uyumu hastalar tarafından da oldukça önem verilen bir konudur.

Diş rengi seçiminde farklı yöntemler kullanılabilmektedir: renk skalaları ile görsel renk seçimi ve dijital cihazlar yardımı ile renk seçimi. İnsan gözü, renkler arasındaki en küçük farklılığına bile çok hassasdır. Ancak; renk skalaları kullanılarak yapılan renk seçiminde renk algısı subjektifdir. Hekimin yaşı, cinsiyeti, tecrübesi, ruh hali, hastanın başının pozisyonu, ortam koşulları, kullanılan ışık kaynağı gibi çok çeşitli faktörler görsel renk seçimi sonuçlarını etkileyebilmektedir. Bu derlemede, diş hekimliğinde renk skalaları kullanılarak yapılan görsel renk seçimini etkileyen faktörler anlatılmaktadır. Renk algısının subjektifliği, renk seçim prosedürünün karmaşıklığı ve dijital renk ölçüm cihazlarında oluşabilecek problemlerden ötürü; diş hekimliği renk seçim prosedüründe dijital ve görsel renk seçim yöntemlerinin birlikte kullanılması önerilmektedir.

Anahtar Kelimeler: *Diş rengi, görsel renk seçimi, estetik diş hekimliği.*

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OVERVIEW / GENEL BAKIŞ

Changes in today's esthetic perception and the increase in esthetic demands of patients directly affect materials, techniques, and treatment procedures in dentistry (1). Obtaining a good color match between restorations and natural teeth is one of the most important steps for esthetics in dental practice (2). Tooth shade occurs as a result of the scattering and absorption of light on the tooth surface on the enamel and dentin surface (3). The tooth shade selection is a complex procedure due to the polychromatic nature of the tooth structure and regional changes in its translucency (4).

The most commonly used method for shade selection in dentistry is the comparison of tooth shade with porcelain or acrylic resin-based tooth shade guides (5, 6). However, this method is subjective and there are many factors that affect the selection of tooth shade such as age, gender, eye fatigue, experience, lighting conditions, and environmental conditions (2, 3, 7). The lighting condition of the environment is considered to be the most important factor affecting shade selection; changes in lighting conditions can cause changes in perceived color (8). Due to factors affecting tooth shade selection, more objective methods have been developed for tooth shade selection: such as RGB devices, colorimeters, spectrophotometers, spectroradiometers, and digital cameras (3, 6, 7, 9). Tooth shade selection made with these digital devices are considered to be more reliable and objective (10). However, many problems can occur due to incorrect calibration or incorrect use of digital devices (10).

The most preferred tooth shade guides in visual tooth shade selection are Vita Classic (Vita Zahnfabrik, Bad Sackingen, Germany) and Vita 3D Master (Vita Zahnfabrik, Bad Sackingen, Germany) (6, 11). While the Vita Classic tooth shade guide consists of 16 colors; the Vita 3D Master tooth shade guide, introduced in 1998, consists of 26 colors (11). By designing different tooth shade guides, the limitations of visual shade selection are tried to be eliminated (2). However, there are many variables that can affect color perception such as age, gender, eye fatigue, experience, lighting conditions, environmental conditions, patient position in visual shade selection (2, 6, 7). Color perception not only varies between individuals, it can also differ for the same individual over time (6).

Factors Affecting Tooth Color Selection

1. Physician-Related Factors

There are various factors that can affect color perception such as the physician's age, gender, professional experience, eye fatigue, and mood in visual shade selection (3, 12, 13).

There are different ideas in the literature on the role of gender in shade selection. In humans, the cone cell pigment gene is located on the X chromosome (14). If women are heterozygous, they can be tetra-chromatic, which can give an additional advantage in color perception (14). Based on this information, it is thought that women are more successful than men in shade selection (14). As there are studies (15, 16) reporting that women are more successful than men in tooth shade selection and gender has an important role in selecting tooth shade; there are also studies (17, 18) claiming that gender is not an important factor in tooth shade selection. Unlike these studies, there is also a study (19) showing that men are more successful

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in selecting tooth shades. Many studies have shown that gender is not an important factor in tooth shade selection (3, 18, 20, 21).

It is claimed that the age of the physician is another factor in tooth shade selection (22). It is thought that the color perception may change as a result of wear on the cornea and lens with advancing age (22).

The role of professional experience in tooth shade selection is again a controversial issue. There are studies (17, 22, 23) showing that professional experience and knowledge are important in tooth shade selection; as well as studies reporting that professional experience has no effect on tooth shade selection results (12, 21, 24-27).

Eye fatigue is another factor affecting the physician's success in selecting tooth shades. (28). Looking at a tooth or tooth shade guide for more than five seconds, the eye gets used to that color and adjusts itself (29). When looking at a white surface after looking at any colored object for a long time, it appears with a color tone complementary to the image of the same object (29). For example, it has been reported that the blue color causes the after-image to direct the perception to its complementary color, orange (30). In this case, it can mislead the color perception by selectively exhausting the orange cones in the eye (30). This condition is defined as color tone sensitivity and is thought to be very effective in shade selection (29). Based on this information and studies, it was concluded that the first shade selections made by physicians in a short time were more accurate (30).

2. Lighting Conditions

Three main factors that create the perception of color; light, object, and observer (31). Metamerism occurs when the relationship between these factors changes (31, 32). Metamerism is the perception of two colors that appear identical under a light source; differently under a different light source (31, 32). It is important to standardize illumination between the clinic and laboratory in order to reduce the negative features of metamerism in dentistry (10).

The light source has critical importance due to its effect on the quality and intensity of the light reaching the teeth for shade selection (3, 33). If the light source changes, the light reflected from an object also changes, in which case a different color is perceived (8). The energy distribution of light affects color perception (29). Physicians should choose a light source that is not dominated by any wavelength when choosing colors; because when an object is viewed under lights dominated by certain wavelengths (color bands), that particular color becomes dominant and misleading for the observer (29).

There are three types of light sources:

- **Incandescent Light:** Provides the propagation of yellow waves in high concentration (29). It is not suitable for tooth shade selection (29). Its color rendering index (CRI) is low (29). CRI is a quantitative measure of the ability to reproduce the colors of various objects compared to a standard light source (29). It is recommended to have a CRI value above 90 to make an ideal shade selection (34, 35).

- **Fluorescent Light:** It emits blue waves in high concentration (29). It is not suitable for tooth shade selection (29). Its CRI value is between 50-80 (29).

- **Natural Daylight:** Northern daylight is considered to be the most ideal light source for tooth shade selection (29). Because it is the closest to emitting the full spectrum of white light (29). It is used as a standard

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to evaluate other light sources (29). The average color temperature of daylight is about 6500 °K (29); however, it depends on the time of day, cloudiness, humidity, and pollution (29). Its CRI value is close to 100 (33).

The lighting condition of the environment is an important factor affecting color perception (3, 36). A neutral light or northern daylight, no color tone (such as blue, red) is dominant, is recommended as the most ideal lighting conditions for tooth shade selection (15). The light source with a temperature of 6500 °K represents daylight (37). Although daylight is considered a standard when compared to other light sources, direct sunlight should not be used in tooth shade selection (29, 35). The time of day, time of year, and weather conditions affect the color of sunlight; therefore, daylight considered to be standard is rarely found, ideal conditions cannot be reached at all hours of the day (8, 15, 26, 38). In the morning and evening hours, short blue and green waves are seen to be reflected and only longer waves to penetrate the atmosphere (29). That's why dawn and sunset are rich in sunshine, yellow and orange; lack blue and green colors (29). Northern daylight at noon on a bright day is considered ideal because the daylight during these hours is in balance in the visible light spectrum (29). Due to the fact that ideal conditions cannot be provided, it is recommended to use light sources close to daylight in order to standardize lighting conditions and increase shade selection success (8, 39).

Dental unit lights are incandescent lights that usually emit a high proportion of red-yellow and low blue light; they should not be used for tooth shade selection (34, 40). The intensity of light is another factor to consider when selecting tooth shade (41). In cases where the light intensity is too low, it becomes difficult to perceive fine details and errors occur in the selection of the main shade (41). In cases where the light intensity is high, it causes eye fatigue and again the wrong choice of the main shade (41). Dental unit lights are very bright and cause eye fatigue (30). Shade selection should not be made without resting eyes after working under the dental unit lights for a long time (30).

3. Environmental Conditions

The color of the wall of the environment where the shade is chosen is one of the important factors in color perception (30). For the successful shade selection, the walls of the clinic should not be bright colors (38). The ideal wall color for dental clinics and laboratories is neutral gray with 18% retroreflection (29, 30). Neutral gray is colorless and soothes cone receptors in the eye (30). The blue wall color, which was recommended for dental clinics in the past, is not recommended today because it makes the color perception of orange, which is the complementary color of blue, more dominant during shade selection (30, 33). Various environmental factors such as wall color and the dentist's colored clothing are particularly important for older teeth with worn, shiny surfaces (30). Because these shiny surface teeth have a higher potential to reflect the surrounding colors and therefore create the false color perception (30).

4. Patient-Related Factors

In tooth shade selection, it is important that the patient's head is in an upright position and the physician is at eye level (33). Lipstick and colored clothing are misleading factors in the physician's selection of tooth shade (22). Lipstick should be removed and a neutral-colored patient cover should cover colored clothing (33). The ideal color to be preferred for this purpose is neutral gray (30). Some studies also suggest the blue color for this purpose; however, blue causes the after-image and directs the perception to its complementary color, orange (30). In this case, the orange cones become selectively tired and change color perception (30).

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Staining on the tooth surface and poor oral hygiene may cause errors in tooth shade selection (38). For this reason, external stains on the tooth surface to be chosen for color should be removed by polishing (38). Tooth shade selection should be done before any oral procedure that dries teeth (33). In addition, the roughness of the surface structures of natural teeth can cause the reflection of light on the tooth surface at different angles and affect color perception (38).

SUMMARY / SONUÇ

Visual tooth shade selection using tooth shade guides is a complex procedure that can be affected by many factors. Environmental conditions, light source, special conditions regarding the physician, and the patient cause the visual shade selection data to be subjective. The shade selection is recommended to do with digital devices such as RGB devices, spectrophotometers, spectroradiometers, and colorimeters in order to make the obtained shade selection data more reliable, objective, and repeatable. However, using the digital method alone has several disadvantages. The ideal procedure in shade selection in dentistry is the combination of visual and digital shade selection methods under appropriate conditions.

Acknowledgements / Teşekkür

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