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Subjective and Objective Methods of Shade Selection - A Comparative Study

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Abstract: **With the advent of spectrophotometry, the chore of selecting the shade of a tooth became extremely easy. However, every new advent in technology comes with a high price. The question then arises as to whether the conventional method was inaccurate and definitely needed replacement. This study was carried out with the aim of assessing the reliability of the conventional shade selection techniques and to see whether spectrophotometers are a must in dental practice.**

The study was conducted in two main steps. The objective method of shade selection using a spectrophotometer and the subject method using two commercially available shade guides. For the subjective method 150 participants were selected with no bias towards gender or level of experience. Participants were subjected to a color training program to check for their visual acuity. They were then asked to choose the shades of four preselected shade tabs using both the VITA Classical® and VITA 3D Master® shade guides. Data was statistically analyzed using IBM-SPSS (Version 22)

The objective method showed the best accuracy with a 100% accuracy rate. Chromatic perception disability played a role in the accuracy of subjective methods of shade selection. Participants proved to be more accurate with VITA Classical® shade guide over the VITA 3D Master® shade guide. Experience proved to be a factor in accuracy of shade matching while using VITA 3D Master® shade guide.

Subjective methods of shade selection is influenced by the chromatic perception disability and especially showed significance (p=0.000) for the VITA Classical® shade guide. Accuracy levels with VITA Classical® varied with experience seen as Students 82.4%, General Practitioners 50% and Specialists 90%. VITA 3D Master® was seen to be accurate more with General Practitioners (66.7%) and Specialists (40%) than with Students (17.6%).

Keywords: **Subjective and Objective Methods, Shade Selection.**

1. INTRODUCTION

With the advent of spectrophotometry, the chore of selecting the shade of a tooth became extremely easy. However, every new advent in technology comes with a high price. The question then arises as to whether the conventional method was inaccurate and definitely needed replacement. Previous studies such as the one performed by Horn et al 1998 concluded that spectrophotometry is a more predictable way of assessing tooth shade than the human eye. On the other hand, a study by Fani G (2007), showed that there is little positive correlation when determining tooth shade.

Aim of the study:

To assess the clinical accuracy of the conventional shade selection technique compared with that of using a spectrophotometer.

2. LITERATURE REVIEW

Color in Dentistry: Is "Everything We Know" Really So?

Author: Paravina, (June 2010)

In this article Paravina stated that, being an experienced practitioner does not necessarily mean that one is trained in color matching. Findings vary on whether shade-matching quality increases with years in practice. What if a practitioner has inadvertently used a suboptimal light source or method during the shade-matching process for many years? If so, perhaps the quality of that practitioner's shade matching would have improved had the practitioner received proper color education and training. Two such programs, conducted under laboratory conditions and simulated clinical conditions, resulted in significant improvements in color-matching results. The author further stated that in the color compatibility section that "Is A2 really A2, regardless of manufacturer and material? Unfortunately, the color compatibility of dental materials of the same shade designation can vary greatly from acceptable results. A E* 2.7 (acceptability threshold) recorded for Only five of 45 pairs of different manufacturer resin composites of the same shade designation, 25 while perceivable color differences were found between ceramic restorations made of nominally the same shades by different manufacturers". Color compatibility can be expressed through coverage error, which is an index that shows the mean value of minimal color difference of shade tabs as related to natural teeth. As compared to permanent teeth, coverage errors of VITAPAN Classical, Bioform™ (DENTSPLYTrubyte, www.trubyte.com) and VITAPAN 3D-Master were found to be 3, 3, and 2.3, respectively. Coverage error reported in other studies was 3.121 and 4.120 for VITAPAN Classical, and 2.6 for VITAPAN 3D Master. As compared to primary teeth, the coverage error of VITAPAN Classical was also 4.1.29 Ceramic denture teeth exhibit more pronounced color transitions as compared with monochromatic polymer based denture teeth. Shade guides for denture teeth, resin composites, glass- and hybrid-ionomer materials, and interim restorative materials are sometimes not constructed of actual restorative material, which may produce unsatisfactory color compatibility. Color variations among different batches of the same material are sometimes present. Using custom-made shade tabs fabricated with the actual batch of the actual material might help in situations like this.

Dental color matching instruments and systems. Review of clinical and research aspects (July 2010)

Authors: Chu, Trushkowsky, and Paravina

The authors stated in this article that Dental shade-matching instruments have been brought to market to reduce or overcome imperfections and inconsistencies of traditional shade matching. The most commonly used shade-matching method is the visual method, whilst Vitapan Classical (Vita Zahnfabrik, Bad Sa¨ckingen, and Germany) and its derivations are probably the most commonly used shade guides. The colored tabs of distinctive shades organize the empiric-based Vita chart. In addition, unequivocal findings were reported on color consistency amongst shade guides from the same manufacturer. Introduction of evidence-based Vitapan 3D-Master shade guides, Tooth guide, bleached guide and particularly linear guide by the same manufacturer correspond to color of human teeth and therefore increase chances for successful shade matching. Historically, assessing shade visually has been characterized by several innate difficulties: metamerism, suboptimal color matching conditions, tools and method as well as the receiver's age

fatigue, mood and drugs/medications. Despite these difficulties, the human eye can discern very small differences in color. However, the ability to communicate the degree and nature of these differences is lacking. The final color of an all-ceramic restoration is a merging of the underlying tooth structure or core and the ceramic material. The color of the final restoration cannot match the shade selected from a shade guide unless this modification is taken into account. Therefore, a stump or base tooth preparation shade needs to be obtained and transmitted to the technician.

They further stated that, Spectrophotometers are amongst the most accurate, useful and flexible instruments for overall color matching and color matching in dentistry. They measure the amount of light energy reflected from an object at 1–25 nm intervals along the visible spectrum. A spectrophotometer contains a source of optical radiation, a means of dispersing light, an optical system for measuring, a detector and a means of converting light obtained to a signal that can be analyzed. The data obtained from spectrophotometers must be manipulated and translated into a form useful for dental professionals. The measurements obtained by the instruments are frequently keyed to dental shade guides and converted to shade tab equivalent Compared with observations by the human eye, or conventional techniques, it was found that spectrophotometers offered a 33% increase in accuracy and a more objective match in 93.3% of cases. Crystaleye (Olympus, Tokyo, Japan) combines the benefits of a traditional spectrophotometer with digital photography. Through the development of optical and image processing technology, this product allows the practitioner to match tooth shade and

color more accurately and simply compared with the traditional spectrophotometer. The significant benefit of this system is that 'virtual shade tabs' in the computers database can be cross-referenced and superimposed visually onto the natural tooth image to be matched giving the technician the ability to visualize the correct shade tabs. The digital image produced by the Crystaleye uses a 7-band LED light source, which results in a more precise depiction of color than the conventional systems used with digital cameras. Moreover, the image produced by the Crystaleye is taken from inside the oral cavity and consequently is devoid of the external light that can cause discrepancies. Vita Easyshade Compact (Vita Zahnfabrik, Bad Sa¨ckingen, Germany) is cordless, small, portable, cost efficient, battery operated, contact-type spectrophotometer that provides enough shade information to help aid in the color analysis process.

Different measurement modes are possible with Easyshade Compact: tooth single mode, tooth area mode (cervical, middle and incisal shades), restoration color verification (includes lightness, Chroma and hue comparison) and shade tab mode (practice/training mode).Shade-X (X-Rite, Grandville, MI) is also compact and cordless ''spot'' measurement'' spectrophotometer with 3-mm probe diameter, and keyed to the majority of popular shade guides. Shade-X have two databases to match the color of the dentin (more opaque) and the incisal tooth regions(more translucent).SpectroShade Micro (MHT Optic Research, Niederhasli, Switzerland) is an imaging spectrophotometer. It uses a digital camera/LED spectrophotometer combination. It has an internal computer with the analytical software. The tooth positioning guidance system, shown on the LCD touch screen, is used during color measurement. Images and spectral data can be saved on the internal memory and transferred to computer.

Conventional Versus Spectrophotometric Shade Taking For The Upper Central Incisor: A Clinical Comparative Study (November 2010)

Authors: Jivanescu, Marcauteanu, Pop, Goguta, Bratu

In this article the authors stated that finding the correct color for a successful aesthetic treatment is a mandatory requirement. In 1998 Okubo and al compared the results of using Vita shade guide and a dental colorimeter.6 Tung and collaborators reported that, when using Vita shade guide by experimented dentists, the correlations with the colorimeter determinations tend to be over 60%.Studies by Paul and others have shown a correlation of 27% in color reproducibility among practitioners who took the shade with the shade guide for central incisors of 30 patients. In the same time, 3 determinations with the spectrophotometer showed a reproducibility of 83%. Another clinical study conducted by Paul and collaborators revealed that the shade determination for porcelain fused to metal crown by spectrophotometer is superior to visual method with the shade guide. Paravina analyzed and compared the arrangement of Vita Classic and Vitapan 3D Master shade guides. They concluded that 3D Master key arrangement is more realistic and suggested arranging the Vita Classic shade guide according to brightness. The conclusion was that the use of 3D Master shade guide decreases the possibility of errors and increases the intermediate precision among practitioner's different determinations.

Dancy and others reported that digital shade match can serve as an alternative to conventional visual methods for restoring anterior teeth with all ceramic crowns.11

A study conducted by Douglas compared the ability to reproduce the color of the target shade tab and concluded that most crowns fabricated by the laboratories in this study, when compared to the prescribed shade tab, were above the clinical threshold for an acceptable shade match under intraoral conditions. In a recent clinical study, crowns fabricated using a dedicated spectrophotometer had a significantly better color match and a lower rate of rejection due to shade mismatch compared to crowns fabricated with a conventional shade-matching method. In our study, observers were students in the 6-th year of the Faculty of Dentistry. The purpose of this study was the analysis of repeatability determinations made by the students with the 2 shade guides and the correspondence determinations measured by the Vita Easy Shade. The mean ΔE was computed for all patients for each shade guide. The result was similar between the 2 shade guides, Vitapan 3D Master having a ΔE mean of 3.45 and Vita Classic a ΔE mean of 3.59 the IBM SPSS Statistics (Version 19) software was used to statistically compare the results of the students with the spectrophotometer results. A frequencies analysis concluded that the correlation percentage between the determinations of the students and the spectrophotometer is 37.5% for both Vita Classic Shade Guide and Vitapan 3D Master Shade Guide.

The authors concluded that that the shade matching for the upper central incisor with conventional shade guide highlights a marked variation between observers. The ratings with Vitapan 3D Master shade guide are more accurate. The Vita Easy shade spectrophotometer can be a useful educational tool for the color management in dental schools.

Differences between the human eye and the spectrophotometer in the shade matching of tooth colour (October-2013)

Authors: Polo a, Polo b, Vinuela b, Vazquez De Parga

The authors in this article stated that, Some authors have suggested that there is a correlation between the human eye and the spectrophotometer.5–7 Others have failed to find any such relationship,8–11 and still others have shown that between human observers and electronic devices there is little positive correlation when determining tooth colour.12,13 The study performed by Horn et al. in 1998 concluded that spectrophotometry is a more predictable and reliable way of assessing tooth colour in human teeth in vitro than the human eye.

The spectrophotometer achieved a reproducibility of 80% while human observers did not surpass 65%. Similar findings were reported by Paul et al. in 2002, the authors concluding that measurements with a spectrophotometer are more precise and reproducible that those made by the human eye (the observers coincided at 26.6% and the spectrophotometer at 83.3%). Spectrophotometers have the drawback that their application in dental practice is hindered by the convex surface of the teeth, which complicates correct placing of the probe tip. Correct positioning of this part of the device is crucial for precise results to be obtained. In any case, the reliability of measurements of tooth colour with spectrophotometers is considered to be better than those made with the human eye. In a study of 3758 teeth it was observed that the spectrophotometric assessment of colour (SpectroShade, medial High Technologies) was identical in 89.6% of the cases, whereas visual assessment of the same teeth provided only 47.9% of cases.

Judeh et al. (2009) compared the subjective method with the objective method of tooth colour measurement and found a significant difference between the digital and visual methods in colour choice. The digital system was seen to have a five-fold greater probability of matching the colour than the visual method.15 In contrast, in another study published the same year by Kuzmanovic´ et al. (2009) failed to detect significant differences in precision in the selection of tooth colour between the conventional technique of visual assessment and use of a colourimetric instrument

The authors further stated that According to their results, the colour dimension where there is the greatest degree of agreement between the operator (observer) and the spectrophotometer is lightness, followed by hue and then Chroma. - Further research is required to determine whether there is a significant relationship between the subjective and objective methods in the selection of tooth shade.

3. MATERIALS AND METHODS

The number of participants that participated in this research was 150 people. They were asked to take part in seven color training exercises that were standardized. These color training exercises were taken from the book written by Rade D. Paravina called “Esthetic color training in dentistry”. The objective of the color training exercises was to arrange a certain set of colored shade tabs from the lightest shade tab to the darkest one with a specific time to complete each exercise depending on the amount of shade tabs that were present in the exercise. The computer software that was used was standardized and had an option of turning the screen Gray in order to neutralize the participant’s vision between each exercise. In addition, the participants were asked to identify the shade of 4 pre-selected shade tabs from the Vita Classic shade guide. Based on Value, Chroma and Hue, the participants were asked to identify the shades using two widely used shade guides, namely the Vita Classic shade guide and the Vita 3D Master Shade guide under regular clinical conditions which were standardized by using the lighting against a tall window (natural sunlight) as well as using a gray sheet of paper to neutralize the participants vision between each sample selection. These readings were compared with those from a spectrophotometer (Vita Easyshade Advance) and the accuracy of the subjective method was analyzed.

Sample Selection:

The participants for this study were based on certain categories and were all members of the Riyadh Colleges of Dentistry and Pharmacy. The categories of participants selected included: Students in their Final Year of Dental school studies, Interns, General practitioners, and Specialists which included Prosthodontics and Restorative Dentists.

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