

# An Alternative Method of Shade Selection for Indirect Dental Restorations: A Case Report

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## Introduction

The matching of shades for “tooth colored” dental restorations continues to be a perplexing issue in restorative dentistry today, although many methods attempt to accomplish this task.

With the increasing esthetic demands of the contemporary dental patient, the fabrication of acceptable indirect, “tooth colored” restorations has become more challenging. Adequate and accurate communication between the dentist and laboratory technician are paramount in meeting these high patient expectations. Additionally, with the recent decline of dental technician training programs, the numbers of well trained laboratory technicians is also on the decline. This increases the likelihood of the utilization of non-local laboratory support, and thus further increases the challenges related to dentist/technician communication.

Recent advances in digital photography have made it an increasingly popular way to communicate existing intraoral detail to technicians. The use of digital images stored in the RAW file format, allow color and exposure information to be accurately corrected using various software packages, if a neutral reference card (white balance card) was included in the image frame at the time of the exposure. Further, when output devices such as computer monitors and printers are precisely calibrated to the International Color Consortium (ICC) standard, the resulting images should closely simulate the “true color” of the subject. In theory, this allows important color information and detail to be communicated to a laboratory technician for fabrication of indirect restorations, without requiring the technician’s presence at the time of shade matching.

## Purpose

The purpose of the case report is to determine if contemporary digital photography techniques can be used by a restorative dentist to accurately communicate color information to a dental technician.

## Methods

Indirect metal-ceramic implant restorations on a maxillary central incisor were fabricated by one technician using two methods of shade matching:

- 1.) Shade selection by technician directly from patient.
- 2.) Shade selection by technician indirectly using a color accurate digital print of the patient’s dentition made by restorative dentist, with reference shade tab included in the photograph.

Both restorations were fabricated by the same technician, however, the technician was “blinded” to believe that the second restoration fabricated was for a different patient than the first, several months after the first restoration was fabricated.

Blind subjective evaluation of each restoration was conducted by 3 prosthodontic residents and the patient. The patient was allowed to choose which restoration was placed definitively.



# Protocol for Production of Color Accurate Print

## Acquisition, Color Correction, and Printing of Intraoral Digital Photographs

Required Equipment: (a) SLR digital camera, (b) Gray card, (c) Dental shade reference tabs, (d) Intraoral Patient Photograph (e) Adobe Photoshop CS2 software and computer (g) Photo quality Printer and photo paper



Canon® 30D with 100mm Macro lens and dual point ring flash – example of an acceptable camera setup.

**Camera Requirements:**  
•SLR camera capable of shooting in the RAW image format.

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WhiBal® calibrated neutral digital gray card (white balance reference), with known L\*, a\*, & b\* values in the CIELAB color space.

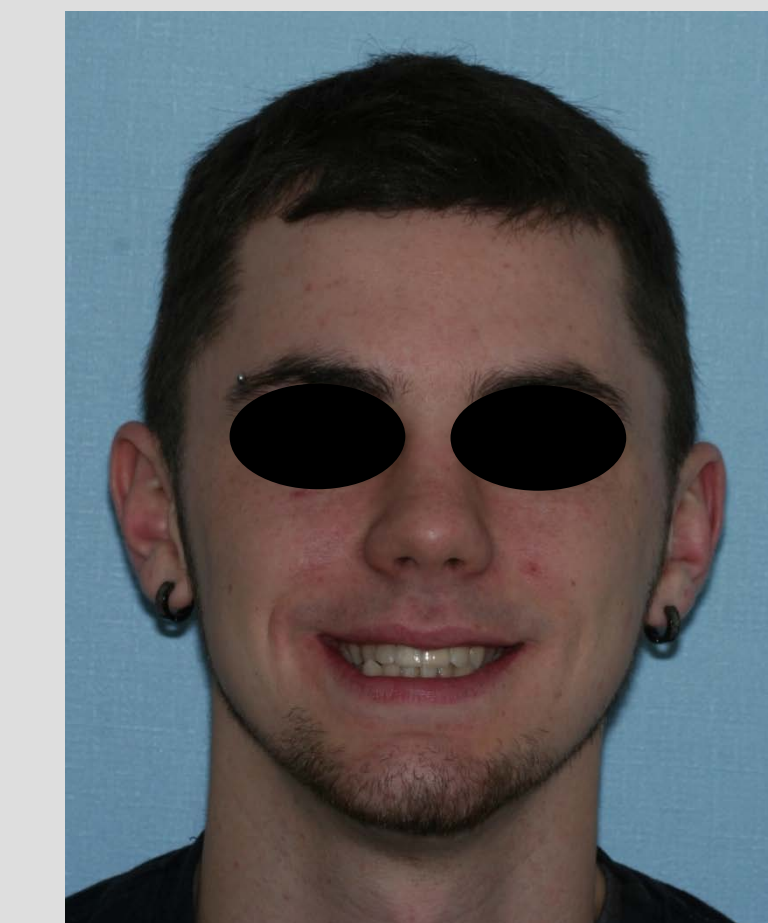
**Gray Card Requirements:**  
•Very neutral- near absence of color ( $a^*$  &  $b^* < \pm 1$ ).  
•Flat Spectral Response – no metamerism.  
•Light gray – more color information is captured in the “upper stop” of the dynamic range ( $L^* = 70-80$ ) – best signal to noise ratio.

+



VITA® 3D-Master Shadeguide  
-A popular tooth shade reference guide.

+

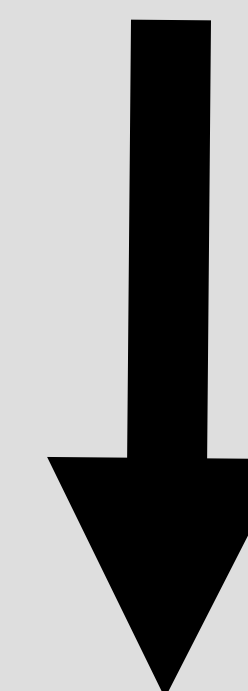


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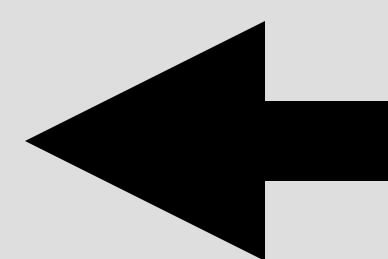


**Intraoral Patient Photograph:**

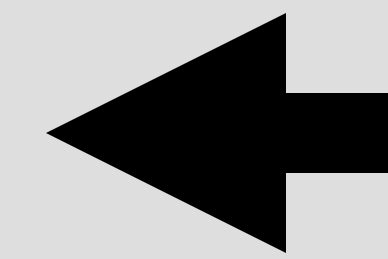
- Shade selection for maxillary right central incisor (#8) implant crown.
- Patient likes crown of #9, and desires #8 to match
- Photograph of Gray Card, tooth #9, and shade tab of closest match (shade in photograph is 2L1.5)



**Color Accurate Patient Photograph used by Dental Technician (see on table)**



Epson R800 – High definition photo quality printer set for use with specific paper as specified by the selected ICC profile for production of color accurate prints



Adobe® Photoshop CS2 used to correct color information in entire photograph, by utilizing the known neutral color information from the gray card  
- Considered to be a “Color Aware” program which can precisely communicate color information to the printer to produce color accurate prints

### Procedure for Production of Color Correct Photographs

- 1.) Set the digital camera to record images in the RAW image format.
- 2.) Select the closest match of shade tab/tabs of the tooth/teeth being matched, as would be done conventionally.
- 3.) Make a digital photograph of the tooth/teeth being matched with the selected shade tabs and the gray card all included, and at the same distance as the teeth.
- 4.) Open RAW digital photograph in Adobe Photoshop CS2 (or newer) and correct the exposure and color (white balance). Color saturation information can be removed for to specifically communicate value, in an additional photograph.
- 5.) Print Photograph through Photoshop, while adjusting the printer settings accordingly so that the printer will print the image utilizing the color space indicated by the selected ICC profile for the printer, and on the appropriate paper.

### **How does ICC relate to all of this?**

The International Color Consortium is a vendor-neutral, cross-platform color management system established in 1993, which allows the transfer of accurate color information between the native color spaces of different digital imaging devices. In short, the well accepted, and internationally utilized ICC specification allows digital images to be viewed by monitor or print with no theoretical color discrepancy.

Almost all newer photo quality printers come preinstalled with a group of ICC profiles. These profiles instruct the printer as to how to properly “lay down the ink” on a particular type of paper. Thus, when an ICC profile has been selected for printing, a specific type of paper must be used in tandem, in order to produce a color accurate print.



## Evaluation of restorations

Blinded evaluation of both restorations was done by 9 Prosthodontic residents, 1 board certified Prosthodontist, and the patient. The patient chose the final restoration to be placed definitively.



Tissue developed site



Crown 1 -Shade and character match by Lab Tech directly



Crown 2 -Shade and character match by Lab Tech via color corrected photo

Evaluator	Crown 1	Crown 2	Comments
Resident 1		X	Crown 2: Better value and translucency #9; crown 1 value too high
Resident 2		X	Crown 2: Better value match to #9; crown 1 value too high
Resident 3		X	Crown 2: Better value; crown 1 value too light
Resident 4		X	Crown 2: Better shade
Resident 5	X		Crown 1: Better value; crown 2 value too high
Resident 6		X	Crown 2: Better
Resident 7	X		Crown 1: More natural; crown 2 too light and bright
Resident 8		X	Crown 2: Better; crown 1 chroma too high
Prosthodontist	X		Crown 1: Better value; crown 2 value too high
Patient	X		

• **60% of evaluators favored Crown 2 (shade and character match via photo)**

• **Patient chose crown 1 for definitive restoration**

### Limitations and Bias

- Adjacent teeth contained little character and internal complexities.
- Results are from only 1 lab technician.
- Only 1 shade tab was included in the photo sent to the technician
- First restoration made by the technician using this technique
- Crown 1 had been in place for several months before blinded comparison was done.

### Conclusions

- Shade and character matching for the fabrication of indirect esthetic restorations may be accomplished using digital photography with reasonable success.
- Dental technician training and experience related to the photo matching techniques would most likely increase the quality and predictability of outcomes.

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