Quantifying the Aesthetic Outcomes of Breast Cancer Treatment: Assessment of Artificial Scars

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Abstract

All breast cancer treatment involves surgery, which inevitably leaves scars. Some previous studies of scarring in other healthcare settings have employed colorimeters. However, specialized colorimetry equipment is not widely used in plastic surgery; instead, surgical outcomes are documented using digital photography. In this study, we used controlled experiments with artificial scars to compare measurements obtained by a colorimeter and a digital camera.

Introduction

Essentially all breast cancer treatment involves surgery, which inevitably leaves scars. The coloration of the scar is an important factor influencing the visibility of the scar. Colorimeters have been used to assess scars, but their use is not widespread in plastic surgery because they are very expensive and require direct patient interaction. On the other hand, it is common practice to take post-operative photographs of patients in follow up visits to document clinical outcomes. Thus, assessment of scar coloration by digital photography is an attractive alternative.

Materials and Methods

A makeup artist (TC) created several types of scars while taking into consideration the reality of the scar from a distance, excessive shine, and the full utilization of latex or collodion makeup. An experienced plastic surgeon (GPR) guided the scar creation. Scars were created by adding base color and top color makeup on a base of either latex or rigid collodion or a combination of these. The scars were modeled by two females in their early twenties representing two major race groups (Model A: White, non-Latino or Hispanic, Model B: Black or African American, non-Latino or Hispanic).

A Minolta Chroma Meter CR300 was used to record color information of specific regions of interest (ROIs) defined by the plastic surgeon. For accuracy and consistency of the measurements, calibration was performed before each scar was created. For each artificial scar, color was measured on the scar region and multiple measurements were performed if the scar varied substantially in width. Anterior-posterior digital photographs were taken under standard clinical conditions with a Nikon 8400. The main light source was overhead fluorescent lighting, and the camera was set to white balance, fluorescent lighting with ISO of 400. The scar and nipple ROIs in the photographs were outlined using the trace function in ImageJ. The RGB values of the ROIs were then converted to the CIE L*a*b* color space using the “C” lighting reference parameters.

Agreement between the colorimeter and photographic color measurements was assessed using a hypothesis test for equivalence. Note that the hypothesis test for equivalence is different from the more common t-tests used to test for an alternative hypothesis of a difference between measurements. In particular, the null hypothesis was that the colorimeter CIE L*a*b* values and the image CIE L*a*b* values are not equivalent. The test statistic ($t$) for assessing equivalence is $t = \sqrt{\frac{(x \pm d)}{s}}$, where $x$ and $s$ are the mean and standard deviation, respectively, of the differences between the measurements of the two readers.

Results and Conclusions

We reject the null hypothesis that the colorimeter and photographic measurements of the color values are not equivalent with an expected variability of 30% ($p < 0.05$). Moreover, the null hypothesis was rejected for the $a^*$ and $b^*$ values ($p < 0.05$) even at only 20% variability. Thus, the magenta and green color values ($a^*$) and blue and yellow values ($b^*$) obtained by the colorimeter or digital photography are equivalent. However, the measurements of the luminance ($L^*$) are more variable between colorimetry and photography. These results suggest that digital photographs digital photography is a reliable, cost-effective measurement method of skin color and can be used in place of colorimeter measurements for the assessment of scar color.

References