Towards Quantifying the Aesthetic Outcomes of Breast Cancer Treatment: Assessment of Surgical Scars

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ABSTRACT
Our long-term goal is to develop decision aids that will improve breast cancer treatment by explicitly taking aesthetics in the consideration. Essentially all breast cancer treatment involves surgery, which inevitably leaves scars. However, the extent and type of scarring is not the same for different surgeries (e.g., different forms of reconstruction.) We present our preliminary experiences in using image processing techniques to quantify scar characteristics in clinical photographs.

INTRODUCTION
The aesthetic outcome of breast cancer treatment is a critical factor in breast cancer survivors’ quality of life. Aesthetics is a general term that refers to physical characteristics such as symmetry and proportion. Essentially all breast cancer treatment involves surgery, which inevitably leaves scars. However, the extent and type of scarring is not the same for different surgeries (e.g., different forms of reconstruction). Presently, there is no quantitative, objective method for assessing the scars resulting from breast surgery. In order to develop decision-aids that will assist breast cancer patients in weighing aesthetics along with other factors, quantitative measures of aesthetic properties such as scarring are needed.

MATERIALS & METHODS
The data set for this study consisted of anterior-posterior (AP) clinical photographs of 40 women who underwent breast reconstruction at The University of Texas M. D. Anderson Cancer Center. All of the reconstructions were performed using the Transverse Rectus Abdominis Myocutaneous (TRAM) method, 16 of which used a mastectomy with wide skin removal (TRAM-SR) and 24 of which underwent TRAM following skin-sparing mastectomy (TRAM-SS).

The digitized/digital photographs were analyzed using Image J (National Institutes of Health). For this preliminary study, all regions of interest (ROIs) were manually delineated using the polygon selection tool. Two kinds of measurements were calculated for each image by two observers (MSK, WNR) on the same image set on two occasions. The size of the scar was computed as a ratio of the area of the scar region to the total area of the affected breast (AR). The intensity gradient of the scar versus the surrounding normal skin was computed as the ratio of the absolute value of the difference in mean intensity of scar and surrounding normal regions to the average intensity of the surrounding normal region (NIG). For the TRAM-SR reconstructions, the intensity of the scar region was also compared to that of the flap region (FIG).

RESULTS & DISCUSSION
The correlation coefficient was used to assess the inter- and intra-observer agreement in the measurements. The intra-observer correlation was high (r = 0.71-0.96) for all measures except those of AR and NIR on the TRAM-SS cases using the second observer’s ROIs (r = 0.29, r = 0.33). The inter-observer agreement was high for TRAM-SR AR (r = 0.71) and FIG (r = 0.91), but low to moderate for the other measures (r = 0.20-0.50). One reason for these differences is that the identification of an ROI of “normal” skin seemed to be more variable than for identifying “flap” skin.

The AR measurement suggests that the percent of the breast area affected by scar is larger for TRAM-SR (observer #1 mean 6.5%) than for TRAM-SS (observer #1 mean 4.1%). This is consistent with expectations in that in skin-sparing procedure the incisions should follow the inframammary crease and thus be less visible, especially in an AP view.

Both area and intensity measures appeared to be affected by patient positioning and breast size. These factors affect shadow placement in a photograph that can make a scar more or less visible.

The results presented are encouraging that objective quantitative measures could be computed from photographs for assessing surgical scars. However, this was a pilot study and additional work is needed.