Predicting Breast Reconstruction Outcomes for Autologous Breast Reconstruction Patients

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Abstract

We are developing a case-based reasoning (CBR) algorithm to help breast cancer patients visualize the outcomes of breast reconstructions. We hypothesize that current reconstruction patients who are pre-operatively similar to a previous patient can undergo the same reconstruction procedure with similar post-operative results. Thus, a previous patient's outcomes can be a good indicator of a new patient's outcomes. We analyzed 15 delayed, autologous, unilateral breast reconstruction patients. We used several pre-operative and post-operative features to determine which features resulted in high correlation and thus are good predictors of reconstruction outcomes. We found that while there did not seem to be a significant correlation between the patients regarding most features used, there was a significant correlation regarding pre-operative body mass index (BMI) and the number of days since radiation treatment.

Background

• Breast reconstruction is an important step in the process of breast cancer rehabilitation.

• Current decision aids can help educate patients about their decisions but are not personalized to each individual patient.

• Decisional conflict and regret are common among women while they make decisions regarding their breast reconstruction.

• We hypothesized that new reconstruction patients (target patients) who are pre-operatively similar to a previous patient (reference patient) can undergo the same reconstruction procedure with similar post-operative results.

• Case-based reasoning (CBR)[1] is the process of solving new problems based on the results of similar past problems.

• Our objective is to use CBR to predict the surgical outcome vs. the operation outcome for an individual patient and minimize decisional regret and conflict.

Materials and Methods

PATIENT SET

• The patients in the study came from a database of 505 women who underwent breast reconstruction at The University of Texas MD Anderson Cancer Center in Houston, TX.

• Our study focused on the clinical decision making scenario: "I have had a unilateral mastectomy, and currently only have one breast. What will I look like in 3-6 months after my unilateral autologous reconstruction?"

• For this scenario, we had 15 patients who were applicable reference cases; each of the 15 patients was tested acting as the target patient, with the other 14 patients acting as reference patients.

DATA SET

• Each patient had a set of feature data based on demographic and health factors and physiological parameters measured from 3D surface torso images.

• Pre-operative features: age, radiation treatment, days since radiation treatment, pre-operative BMI, breastfeeding, desired post-reconstruction breast size, number of previous pregnancies, smoking history, and baseline breast volume.

• Post-operative features: post-operative BMI, right breast volume at 3 months, and left breast volume at 3 months.

METHODS

• MATLAB was used to create two rank order lists, one based on pre-operative features and the other based on post-operative features (Figure 2).

• Top down correlation[2] coefficients were calculated between the two rank order lists; 15 total coefficients calculated.

• Different combinations of feature data were tested to determine which combinations yielded the highest correlation.

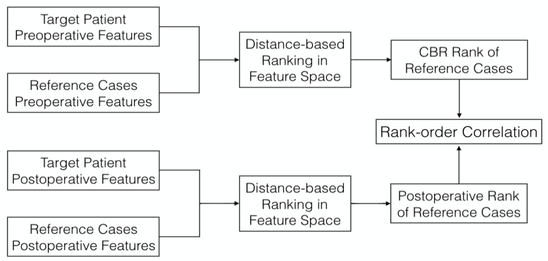

Figure 2. *Diagram showing the method used to calculate the correlation coefficients of the patient set. Similarity of patient was calculated based on distance.*

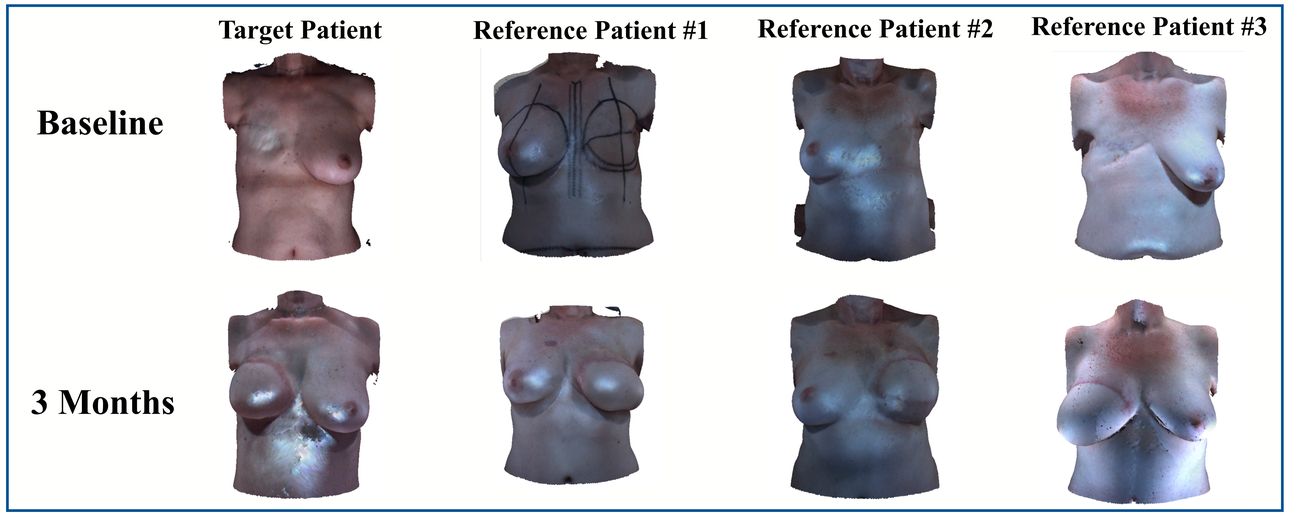

Figure 1. *An example comparison of baseline breast images and 3 month breast images of 4 breast reconstruction patients, with a target patient and the top three most similar reference patients from the resulting pre-operative features rank order list from the CBR algorithm. The top row indicates the patients at baseline (prior to reconstruction surgery) and the bottom row indicates the patients 3 months after surgery.*

Results

• The results of the pre-operative rank order list for a new target patient (Figure 1) differ from the expected results of the post-operative rank order list (Figure 3).

• Most correlation coefficients calculated between rank order lists using all pre-operative and post-operative features were low (Figure 4), while the coefficients calculated with baseline BMI as the sole pre-operative feature yielded higher values (Table 1).

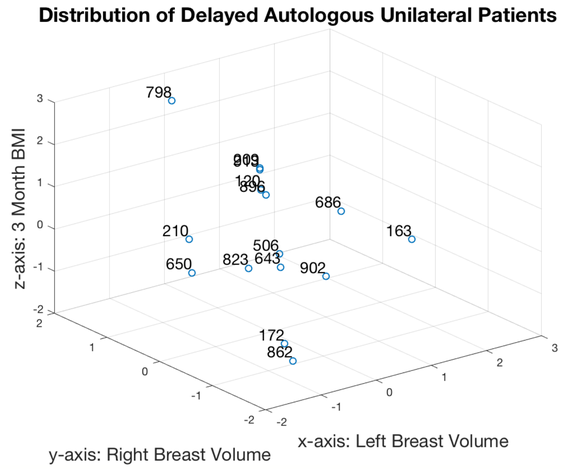

Figure 3. *Three-dimensional plot of delayed, autologous, unilateral patients based on 3-month post-operative data, with left breast volume on the x-axis, right breast volume on the y-axis, and body mass index (BMI) on the z-axis. This figure can be used to visualize the similarities between two patients with distance being the factor in which similarity is determined (i.e. the patient closest in space to the target patient is considered the most similar to the target patient). The numbers correspond to the ID number of each of the patients.*

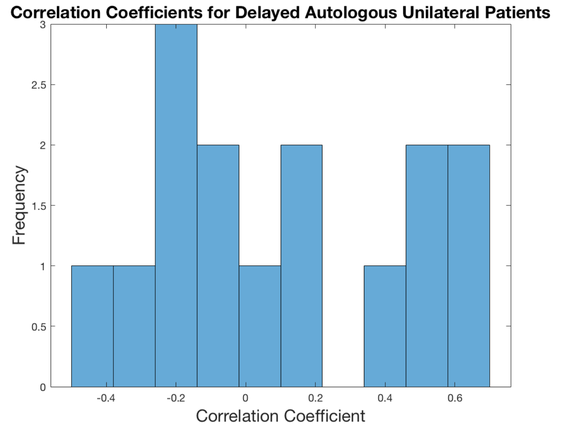

Figure 4. *A histogram showing the frequencies of correlation coefficients for the 15 patients. The x-axis shows the range of the 15 correlation coefficients, determined through a top-down correlation of two rank order lists based on all pre-operative and post-operative features, for each of the 15 patients. The y-axis shows the frequency of occurrence of the correlation value within a range. Most correlation values were low, indicating that usage of all features is not a good method of predicting post-operative outcomes.*

Table 1. Mean and median correlation coefficients for all patients for different combinations of pre-operative features

Features	Mean Correlation	Median Correlation
All	0.08	0.007
Baseline BMI	-0.0075	-0.0376
Baseline Volume	-0.0317	-0.0048
Baseline BMI & Vol.	0.19	0.34

Conclusion

• Overall, there did not seem to be a significant correlation between the rank order lists using all features.

• There was a significant correlation between rank order lists of pre-operative BMI and days since radiation treatment, indicating that these two features are an important aspect in predicting post-operative results.

• The lack of significant correlation could be due to a small sample size (N=15).

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References

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