

Breast volume computation for planning and monitoring fat grafting

House, R¹. Lasso, A¹. Kunz, M². Rudan, J¹. Martou, G¹. Fichtinger, G^{1,2}.

¹Laboratory for Percutaneous Surgery, School of Computing, Queen's University

²Department of Surgery, Queen's University

INTRODUCTION: Breast Cancer is the most frequently occurring cancer in Canadian women. The majority of these patients are candidates for breast-conserving therapy consisting of partial mastectomy and radiation therapy. Following partial mastectomy, up to one-third of the patients experience significant breast deformity, requiring surgical reconstruction. Fat grafting has been emerging as a safe and suitable modality in breast reconstruction of such deformities. The fat, harvested from donor areas of the same patient, is injected into the breast in several fractions, typically 100-150 cc each time. There is always a percentage of fat resorption and more than one surgery is frequently required. Therefore, it becomes imperative to accurately monitor the changes of volume, in order to plan and execute the optimal fat grafting regimen. Currently, there is no available cost-effective, widely available tool for the reconstructive surgeon.

OBJECTIVE: We aimed to provide a system and clinical workflow to accurately compute volume changes of the breast, in a safe and convenient manner during a clinic visit.

METHODS: A 3D surface scan, using the Artec Eva (**Fig. 1 A**) of the patient's upper body is obtained, in a non-contact manner, in a standing pose with hands rested on the hip. The surface scan (**Fig. 1 B**) is imported into 3D Slicer for processing and visual rendering. The breast is separated from the chest (**Fig. 1 C**) along anatomical landmarks, and the volume of the breast region is computed. To assist in planning the total graft volume, volume differences between the two breasts are computed by mirroring the healthy breast onto the reconstructed side. To monitor the retention of graft volume between fat grafting sessions, the volume difference between two consecutive scans of the same breast is computed. Three-dimensional distribution of the volume differences over the breast is visualized on the computer display using semi-transparent surfaces and surface-to-surface distance maps (**Fig. 1 D**).

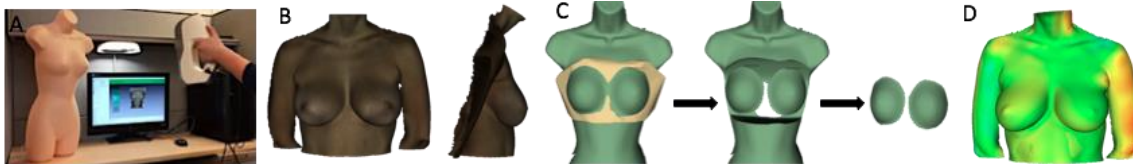


Figure 1. A) Mannequin being scanned by Artec Eva. B) 3D surface scan of a volunteer. C) Isolation of mannequin breasts from upper body surface scan. D) Surface-to-surface distance map of two scans after alignment.

RESULTS: We demonstrated the ability to measure volume differences in the breast in three (3) female volunteers. Each volunteer was scanned three (3) times. Between each scan, the volunteer was asked to relax a few seconds and reposition herself for the next scan. The average difference between three consecutive measurements of the same breast was 1.1 cc. In addition, we also demonstrated the ability to measure the absolute volume of the breast. To this end, a mannequin's breast volume was first measured by water displacement and compared to the volume measured by our system. Having repeated each measurement five (5) times, the average difference between the measurements was 4.1 cc. The difference in the breast volume using water displacement can be attributed to inaccuracies in the technique.

CONCLUSION: Considering the typical volume of a graft injection fraction (100-150cc), our accuracy in measuring breast volume changes (1.1 cc) is highly promising for clinical use. Research Ethics Board approval has been sought to commence clinical evaluation in 25 post breast-conserving therapy patients.