Validation of breast volume measurement using 3D surface scanner

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INTRODUCTION: Breast Cancer is the most frequently occurring cancer in Canadian women, with 5-year survival rate of 88 percent [1]. The standard of care for treating breast cancer normally involves breast conserving surgery and radiation therapy followed by breast reconstruction surgery. For successful breast reconstruction, the total volume loss must be accounted for. Unfortunately, the volume excised during surgery generally does not reflect total breast volume loss, for example, radiation therapy is known to cause volume loss of the breast [2]. To compensate for difference in volume the breast volume can be calculated following radiation treatment and compared against the baseline volume. Many techniques have been proposed to calculate the breast volume but most are invasive, require expensive scans, or produce an underestimation of the breast volume [3]. Our goal is to provide the software and workflow necessary to calculate the breast volume using a non-invasive technique. By calculating and comparing the breast volume of the patient before undergoing reconstruction surgery to the baseline volume will help surgeon's better estimate how much tissue needs to replace in procedures like fat grafting.

METHODS: A 3D surface scan of the patient's chest (Fig. 1-A) is obtained using the Artec Eva Scanner (www.artec3d.com). The scanning process (Fig. 2-B) allows for full visualization of the chest, the scanner is placed on a rolling dolly (Fig 1.-C) under the patient. The scan is then imported into 3D Slicer (www.slicer.org) where modules are used to isolate the target breast and calculate the volume. A model of the patient's chest wall is created by segmenting the chest wall from a chest computed tomography (CT) scan and used to isolate the target breast by subtracting it from the 3D scan. In order to have a ground truth in this study a mannequin was used, the ground truth breast volume was calculated using water displacement. A flat plane was used in place of the segmented chest wall because when using water displacement to calculate the volume a flat cut plane is assumed.

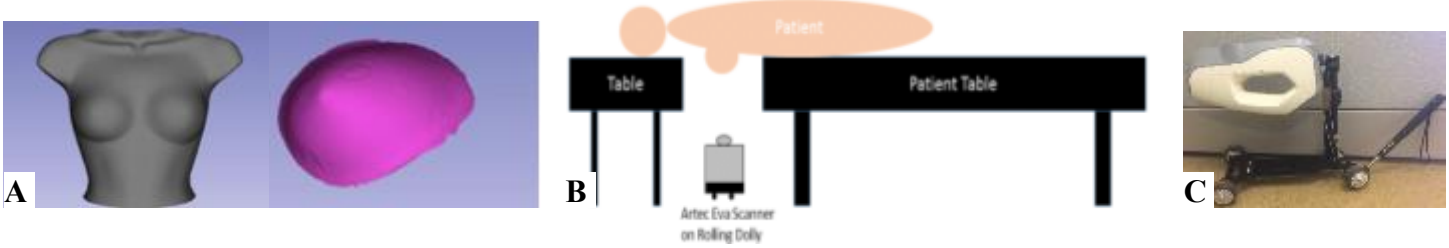

Figure 1. **A)** 3D surface scan of chest using Eva scanner, viewed as a model in 3D Slicer and isolated breast. **B)** Scanning position diagram. **C)** Artec Eva scanner mounted on rolling dolly.

RESULTS: The method provided to calculate breast volume is feasible using 3D Slicer and only requires one surface scan from the patient. The ground truth breast volume of the mannequin was 164mL with a standard deviation of 4.1ml (*n = 5)*. The volume of the mannequin's breast was calculated using the workflow provided, the mean calculated volume was 160.8mL and the standard deviation was 4.7ml (*n = 4)*. In this study the cut plane was manually placed in 3D Slicer, differences between placement of the plane could contribute to the difference in mean values of the calculated breast volume.

CONCLUSION: Using a 3D surface scanner provides a non-invasive and quick way to calculate breast volume. This initial validation suggests this system may be accurate enough to aid the surgeon in the reconstruction process. Further studies will be conducted to assess the accuracy of the system when using the segmented chest wall to isolate the breast opposed to the flat plane.

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