Reliability of 3D Scanned Breast Volume Measurements Within and Between Raters

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BACKGROUND

- ~85% of women wear an incorrect bra size, often associated with discomfort and reduced activity [1]
- Conventional sizing may not accurately represent breast volume
- Objective volume measurement is needed to improve bra fit and support
- 3D surface scanning provides a potentially non-invasive, reproducible solution

This study evaluated the reliability of 3D breast volume measurements to determine its clinical and biomechanical utility.

METHODS

Participants

Healthy females (n = 35)
Mean age = 24.5 ± 5.7 years

Prone 3D Surface Scanning

Define breast boundary with washable marker → Lay prone to capture maximum breast tissue [2] → Scan using hand-held Artec Leo 3D scanner

Digital Segementation

Breast removed from torso in Artec Studio → Breast mesh created and filled posteriorly. Volume calculated in cc

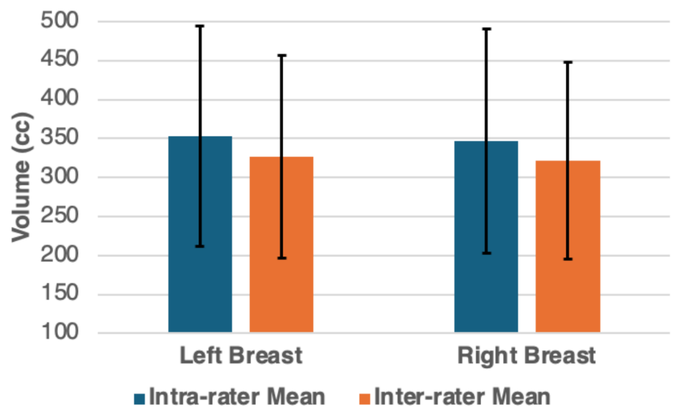
Two Raters Analyze Scans

1. Intra-rater reliability was calcuated from one rater twice
2. Inter-rater reliability was calulated from both raters first volume anaylses

Reliability Analysis

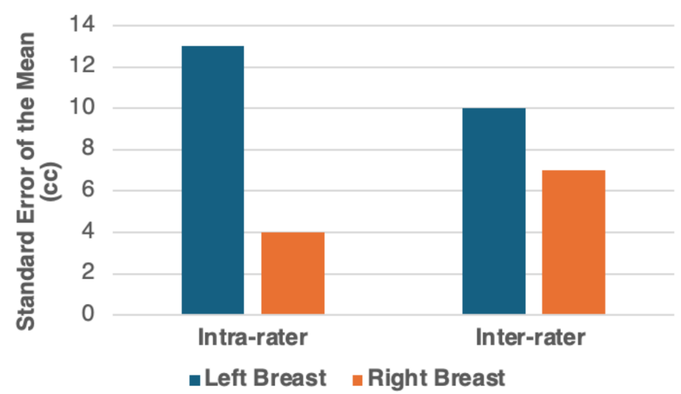
ICC | SEM | MDC

Left and Right Breast Volume by Rater (Mean ± SD)



3D scanning demonstrated excellent intra-rater (ICC = 0.996-0.999) and inter-rater reliability (ICC = 0.985-0.988).

Intra- and Inter-Rater Precision (SEM)



SEM values were small relative to mean breast volume, supporting excellent precision. Intra-rater error was slightly lower for the right breast, while inter-rater error remained consistently low across both sides.

DISCUSSION

- High intra- and inter-rater reliability indicates that 3D surface scanning can consistently reproduce breast volume measurements.
- Low SEM values (1-4% of the mean) relative to mean breast volume suggest high measurement precision, with differences likely reflecting biological variation rather than measurement error.
- Minor inter-rater differences may result from variability in manual segmentation of breast boundaries.
- Findings support the use of 3D scanning for biomechanics and apparel research applications.

CONCLUSION

3D surface scanning provides a **highly reliable** and **precise** method for **breast volume assessment**

- **ICC = 0.985-0.999** Excellent reliability
- **SEM ~ 1-4%** of mean breast volume
- Supports use in biomechanics research and bra design

REFERENCES

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[2] Rizzone, K. H., et al. IJERPH. 2021

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