

Soft Tissue Three-Dimensional Changes Following Malar Implant Placement: Quantifying the Projection Efficiency Ratio

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BACKGROUND

- Malar augmentation is commonly performed in **aesthetic and gender-affirming surgery** using implants
- Quantitative soft tissue effects** of malar implants remain **poorly described** with a lack of objective **morphometric data** quantifying **overlying soft tissue changes in vivo**

OBJECTIVES

- Provide the **first 3D morphometric framework** to quantify **midfacial projection, surface area, and volume changes**
- Apply this framework to characterize soft tissue response following **malar implantation** across implant size cohorts

METHODS

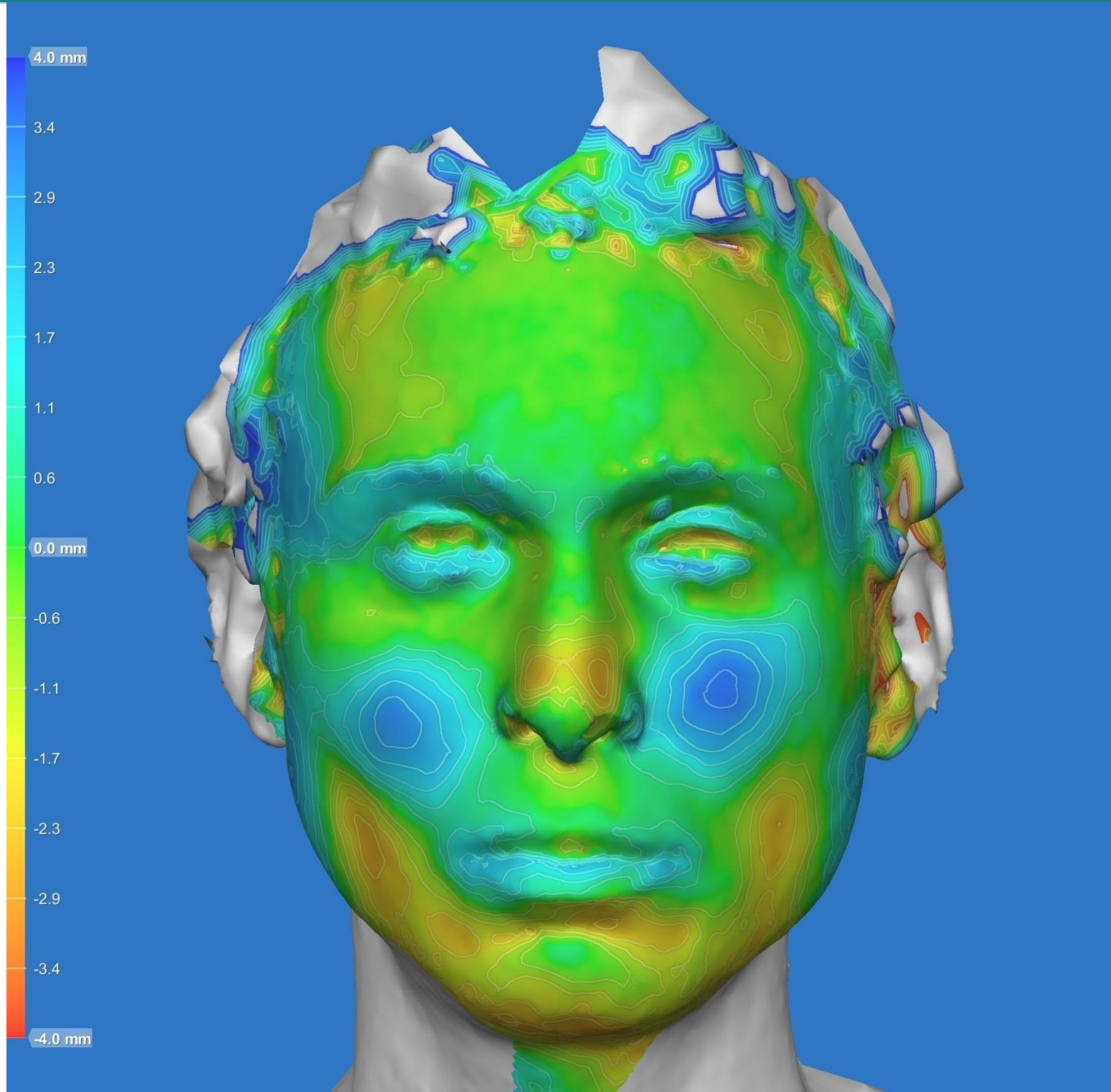
- Data Source:** Patients undergoing facial feminization surgery (FFS) with **bilateral porous polyethylene malar implants** (MEDPOR; Stryker) between 2022 and 2025 at Yale New Haven Hospital
- Postoperative 3D photogrammetry images were registered to baseline using unaltered facial regions and analyzed for **projection, surface area, and volumetric changes** within the defined **malar region of interest**
- Skin thickness** at malar eminence was measured from pre-operative CT using 3D segmentation software (Mimics), calculating the **maximum perpendicular distance** between the cutaneous surface and underlying bone
- Statistical Analysis:** Wilcoxon rank-sum and Spearman’s rank correlation tests
- Bilateral measurements averaged per patient

$$\text{Projection Efficiency Ratio} = \frac{\text{soft-tissue projection gain (mm)}}{\text{implant thickness (mm)}}$$

PATIENT DEMOGRAPHICS

Characteristic	3-mm Cohort (n = 13)	5-mm Cohort (n = 2)	p
Age (years)	36.6 ± 11.2	33.0 ± 2.8	1.000
BMI (kg/m²)	24.3 ± 4.2	35.3 ± 15.0	0.229
Skin Thickness (mm)	1.0 ± 0.3	1.1 ± 0.1	0.686
Follow-up (months)	7.3 ± 8.9	5.0 ± 0.0	0.793

3D Color-Distance Map



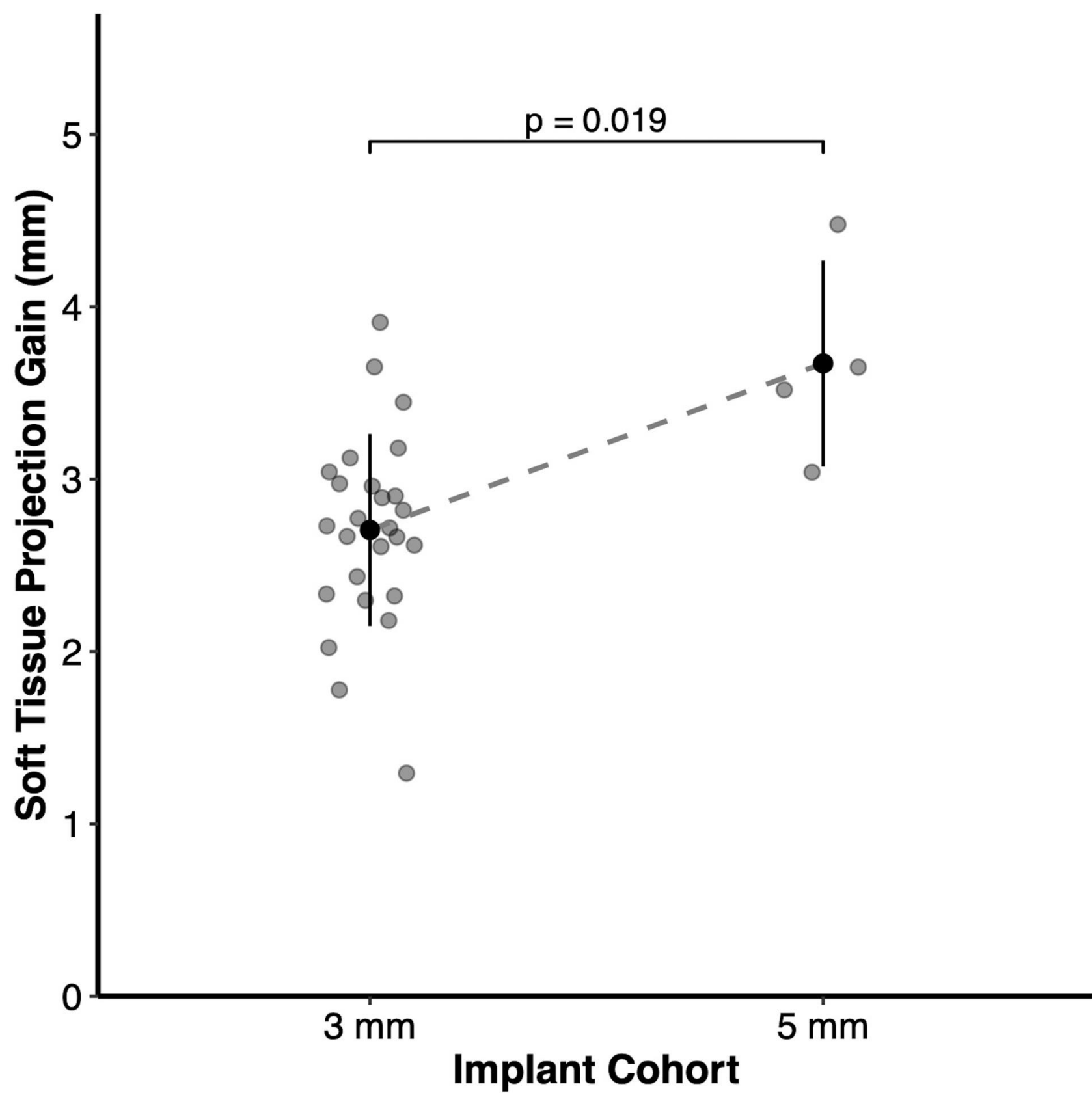
Volumetric 3D color-distance topographic map: warm (red/orange) = projection loss; cool (blue/green) = gain. Patient A, 34-year-old transgender female, 2.9 years post-implantation.

Morphometric Region of Interest Framework



Bilateral malar ROI defined by 5 landmarks (Tragus, Lateral Canthus, Inferior Palpebral Fissure, Medial Canthus, Alar Base) using VECTRA automated loop for surface area and volume quantification.

Soft-Tissue Projection Gain



Point-range plot: 5-mm implants yielded significantly greater absolute soft-tissue projection gain vs. 3-mm (p = 0.019). Statistical significance at patient level.

88%

Mean Soft-Tissue Response Ratio

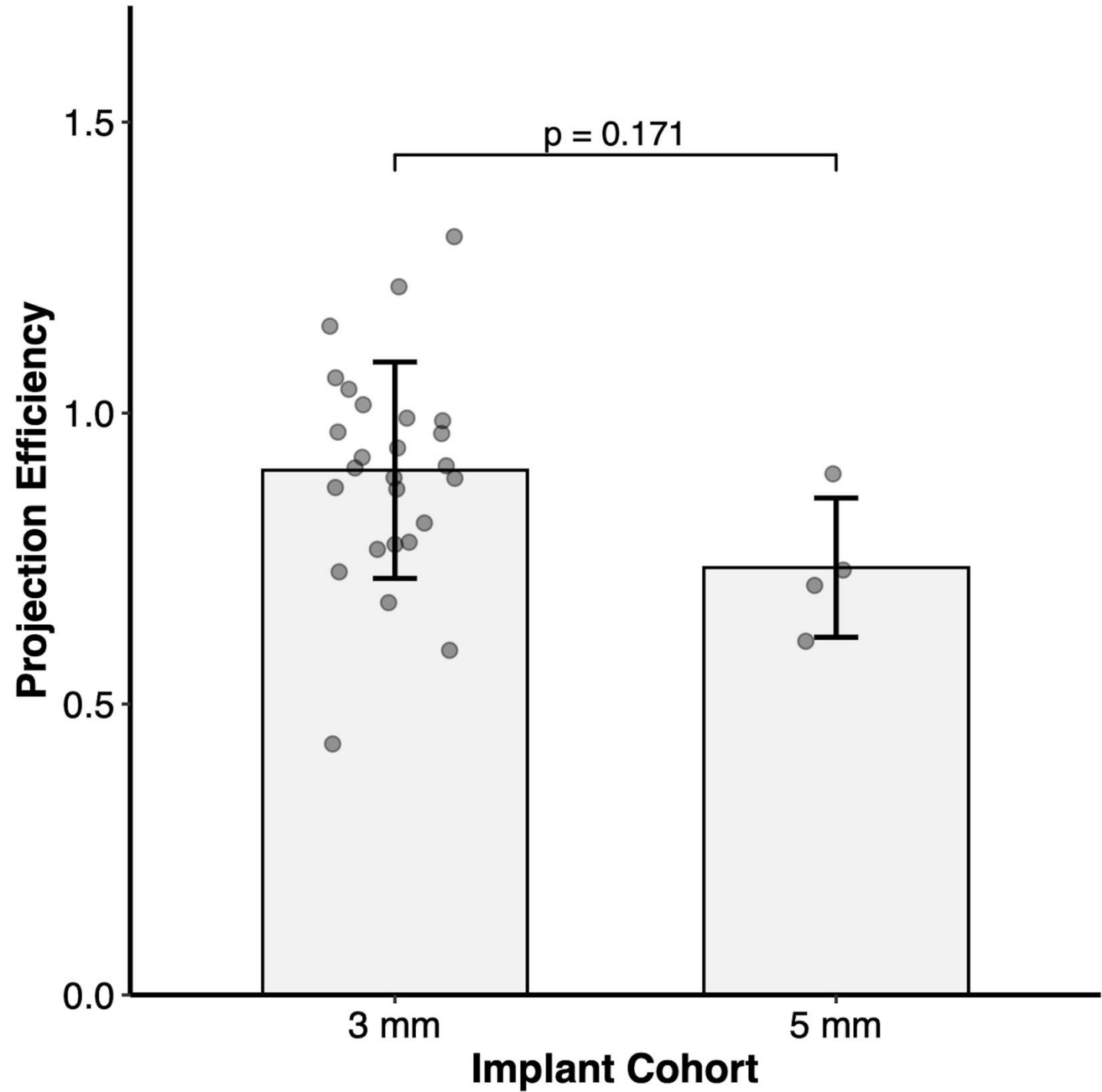
2.70 mm

Mean Projection Gain (3-mm cohort)

3.67 mm

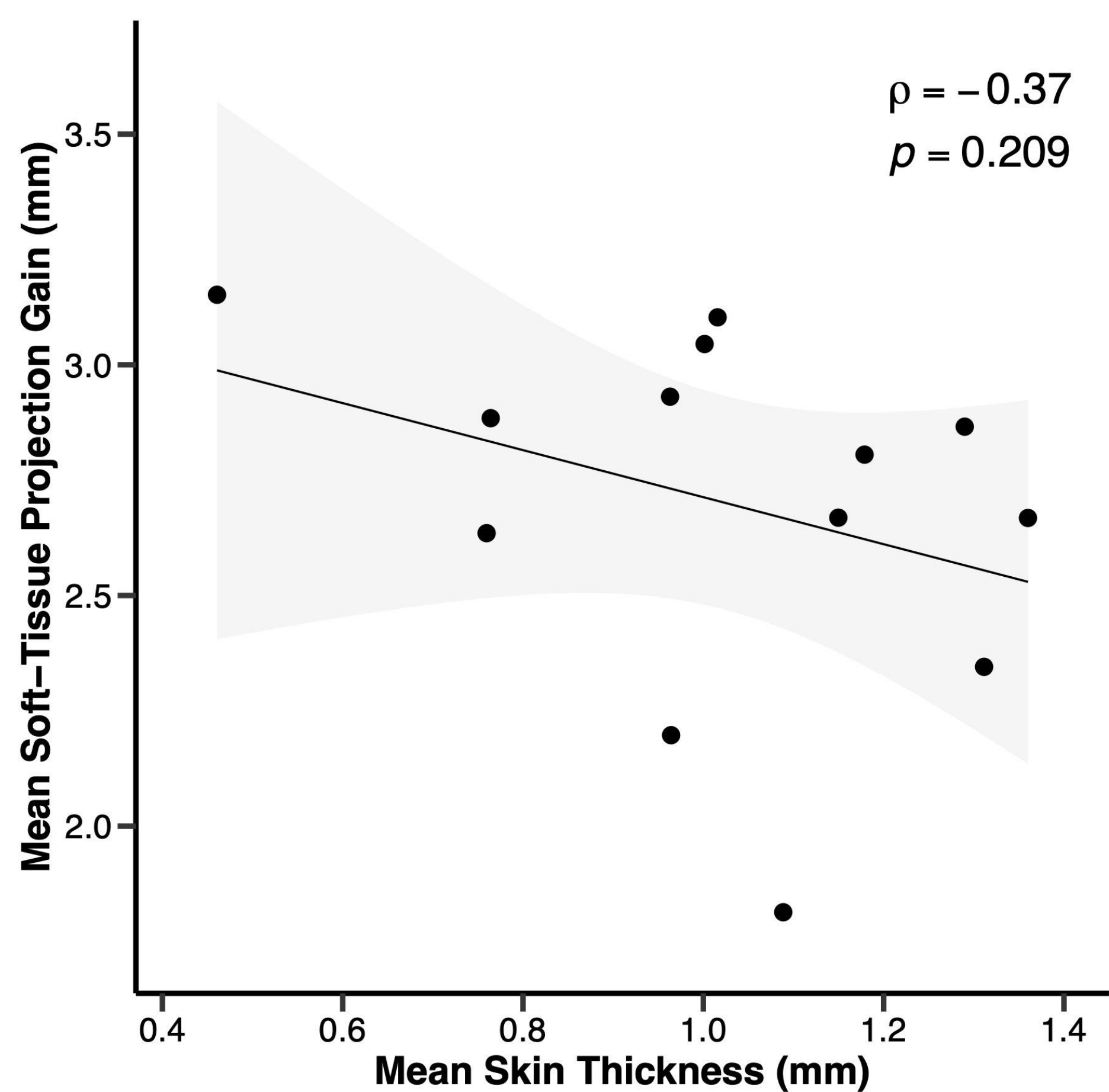
Mean Projection Gain (5-mm cohort)

Projection Efficiency Ratio



3-mm (0.90 ± 0.13) vs. 5-mm (0.73 ± 0.09); p = 0.171. Error bars = SD; n = 30 implants.

Skin Thickness vs. Projection Gain



Spearman's rho = -0.37, p = 0.209 (3-mm cohort). Directionally negative, non-significant correlation between baseline skin thickness and soft-tissue projection gain.

SPEARMAN CORRELATIONS

Predictor	ρ	p-value
Implant Projection (mm)	0.59	0.021*
Baseline Skin Thickness (mm)	-0.22	0.435
Months to Postoperative Imaging	0.23	0.410
BMI (kg/m²)	0.15	0.594
Age at Surgery (years)	-0.15	0.595
Mean ΔRegional Surface Area (cm²)	-0.21	0.451
Mean ΔRegional Volume (cc)	0.48	0.071

MORPHOMETRIC OUTCOMES

Parameter	3-mm Cohort	5-mm Cohort	p
Projection Gain (mm)	2.70 ± 0.39	3.67 ± 0.46	0.019*
Projection Efficiency	0.90 ± 0.13	0.73 ± 0.09	0.171
Δ Surface Area (cm²)	2.02 ± 0.94	1.91 ± 0.78	0.933
Δ Volume (cc)	4.63 ± 3.00	5.60 ± 1.90	0.571

DISCUSSION

- MEDPOR malar implants demonstrated an overall **88% projection efficiency ratio**
- The **5-mm cohort** yielded significantly **greater absolute projection** (3.67 vs. 2.70 mm; p = 0.019), yet demonstrated **lower projection efficiency** (73% vs. 90%)
- Potential threshold effect**
 - As implant volume increases, adjacent soft tissue resistance may attenuate transmission
- A weak, non-significant inverse correlation (ρ = -0.37, p = 0.209) was observed. Thicker soft-tissue envelopes may **attenuate** implant projection
- Limitations:** Small, imbalanced cohorts (n = 13 vs. n = 2); retrospective design; variable follow-up

CONCLUSIONS

- MEDPOR malar implants produce a **significant, high-efficiency soft-tissue augmentation**
- The 5-mm cohort demonstrated greater absolute projection gain (p = 0.019) despite lower efficiency, suggesting a **size-dependent threshold effect**
- This reproducible 3D framework offers a **standardized method** for **evaluating midfacial alloplastic augmentation outcomes**
- This study provides a **preliminary quantitative benchmark** for **preoperative counseling** and **surgical planning**

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