EPITHELIAL AND GRAFT REMODELLING PATTERNS FOLLOWING CORNEAL ALLOGENIC INTRASTROMAL RING SEGMENT (CAIRS) INSERTION

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OUTLINE:

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PURPOSE:

To observe and quantify changes in recipient epithelium and donor ring segment following corneal allogenic intrastromal ring segment (CAIRS) implantation.

METHODS:

High resolution anterior segment optical coherence tomography (AS-OCT) was utilized to map epithelial thickness prior to CAIRS implantation and both epithelium and graft thicknesses at 1 week, 1 month, and 3 months following implantation.

- 19 eyes of 17 patients with keratoconus
- The pattern and magnitude of epithelial thickening and thinning was analyzed via non-parametric Mann-Whitney U-test.

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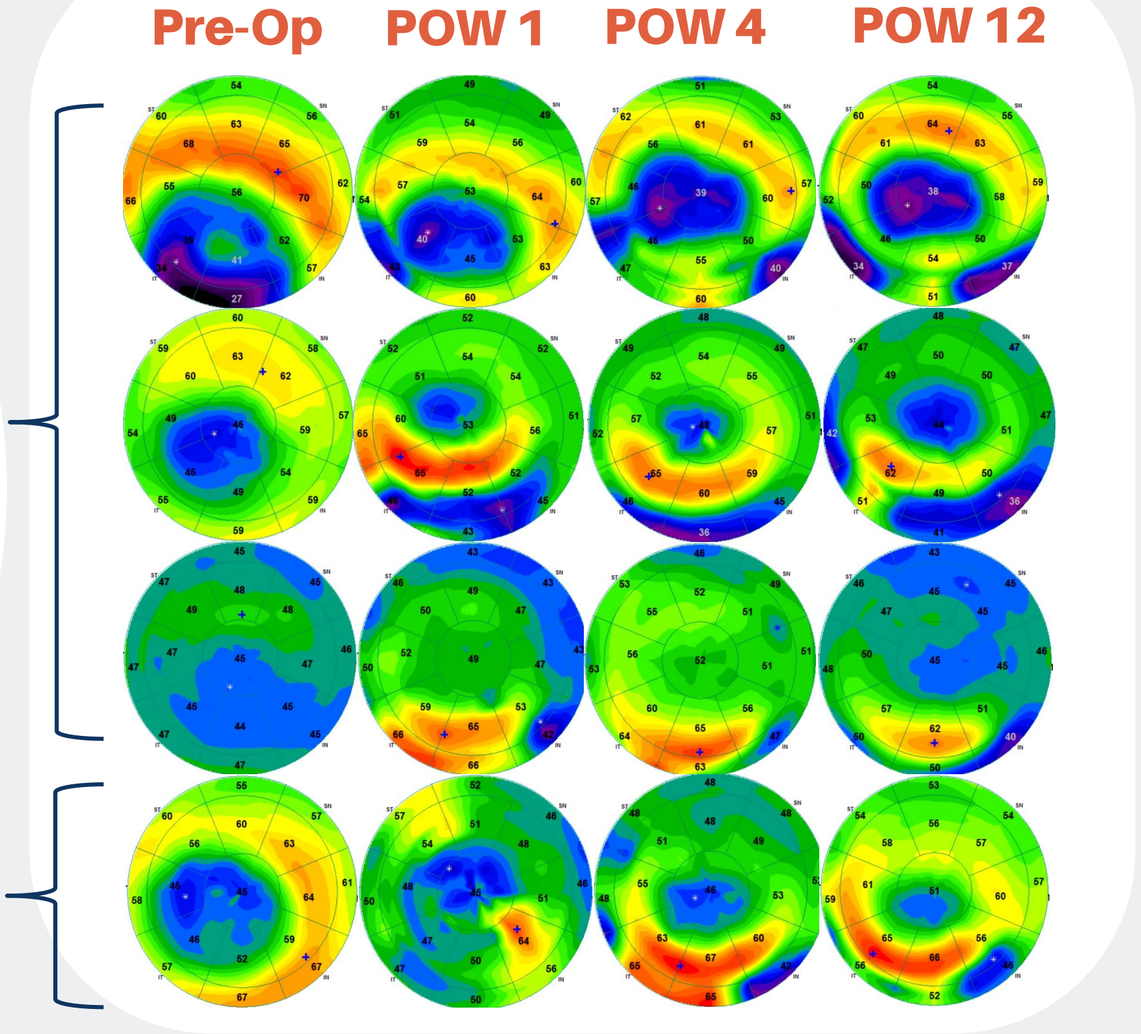
RESULTS:

The pattern of epithelial thickening changed significantly within 1 week of CAIRS implantation and stabilized by 3 months.

Figure 1. Changes in epithelial thickening patterns.



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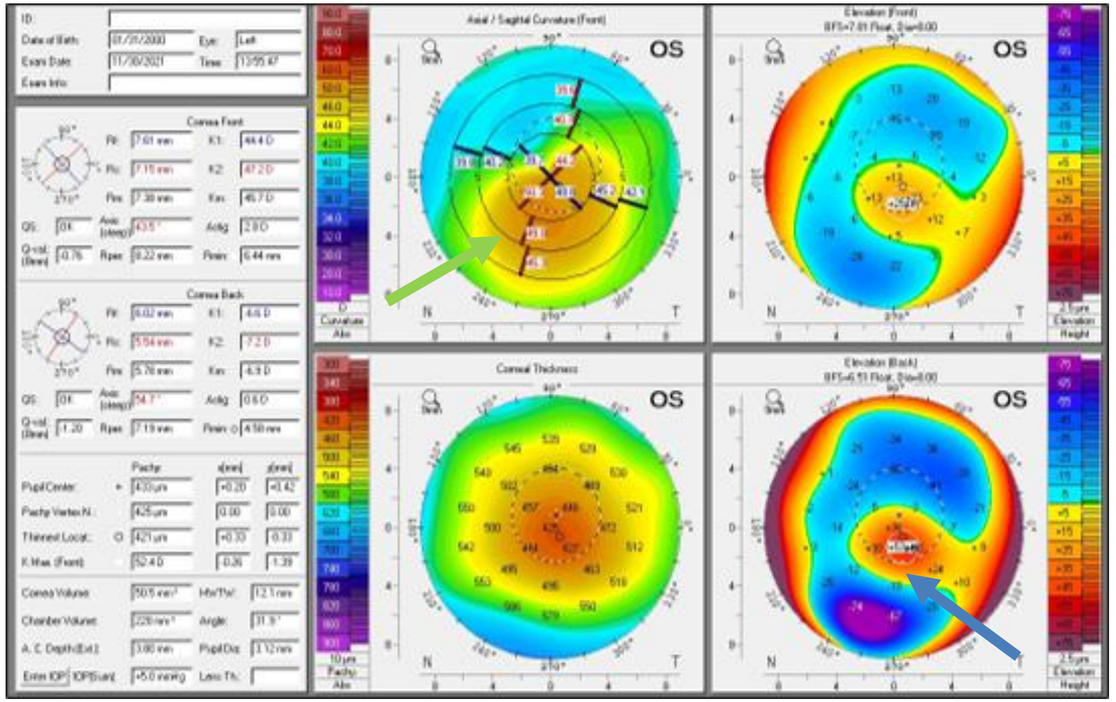
RESULTS:

Figure 2. Pre-operative thickening pattern.

Pre-operatively, a typical pattern of epithelial thickening was observed around the base of the cone and compensatory thinning at the apex.



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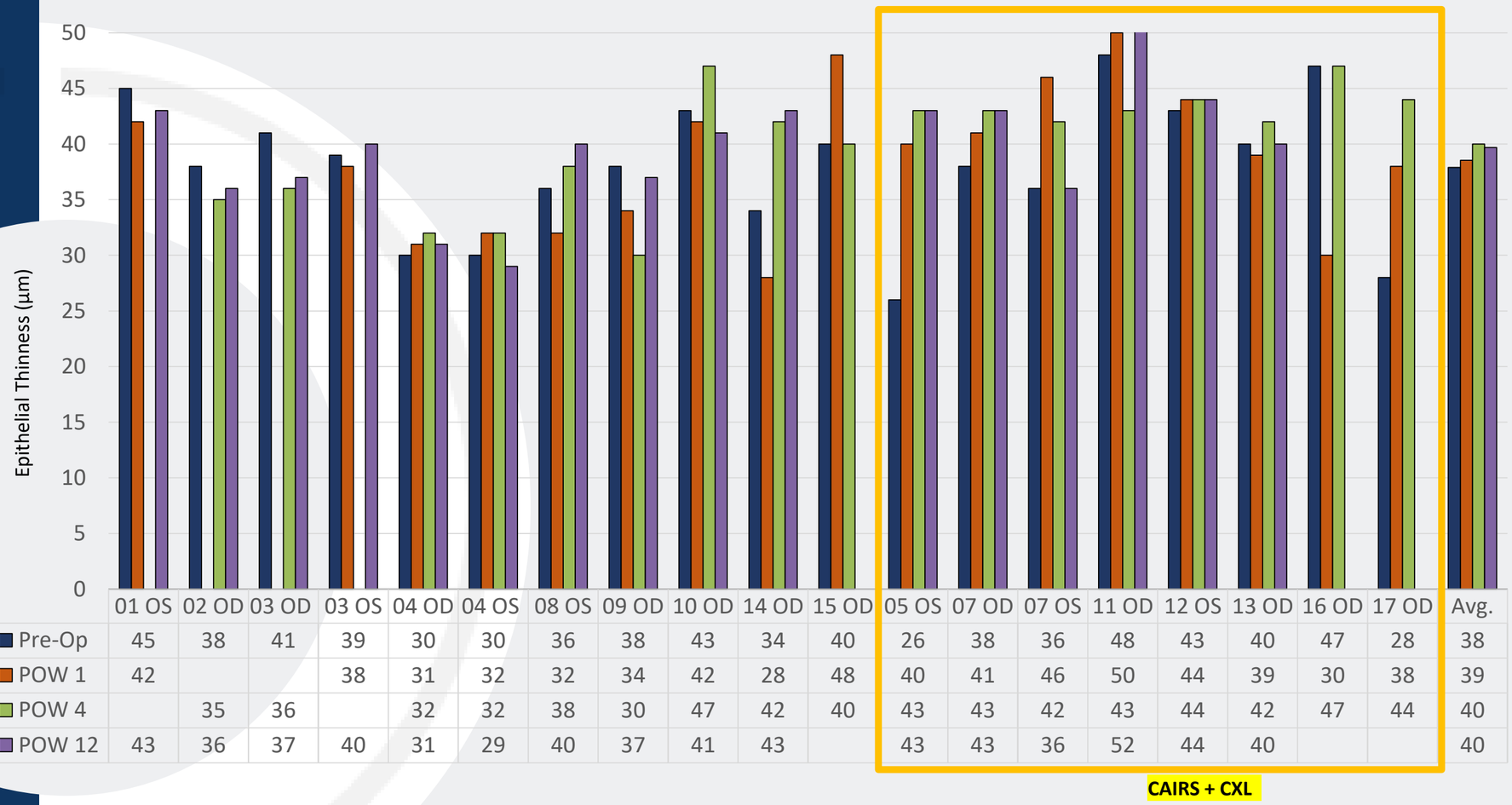
RESULTS:

Figure 3. Thinnest Epithelium Changes.

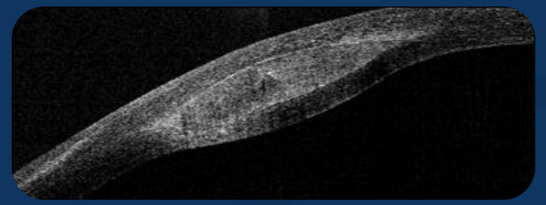


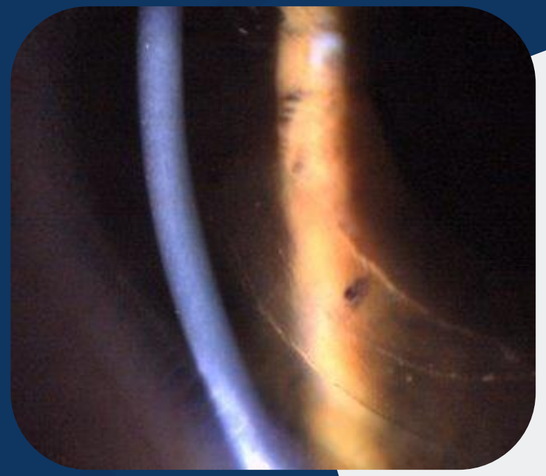
	01 OS	02 OD	03 OD	03 OS	04 OD	04 OS	08 OS	09 OD	10 OD	14 OD	15 OD	05 OS	07 OD	07 OS	11 OD	12 OS	13 OD	16 OD	17 OD	Avg.
Pre-Op	45	38	41	39	30	30	36	38	43	34	40	26	38	36	48	43	40	47	28	38
POW 1	42			38	31	32	32	34	42	28	48	40	41	46	50	44	39	30	38	39
POW 4		35	36		32	32	38	30	47	42	40	43	43	42	43	44	42	47	44	40
POW 12	43	36	37	40	31	29	40	37	41	43		43	43	36	52	44	40			40

Mann Whitney Thinnest Epithelium	P-Value	Thinnest Epithelium Average (um)
Pre-Op	-	38
Pre-Op vs POW 1	0.74	39
Pre-Op vs POW 4	0.18	40
Pre-Op vs POW 12	0.40	40

Therefore, there is never a time when the epithelium can become thinner to compensate for the underlying surface.

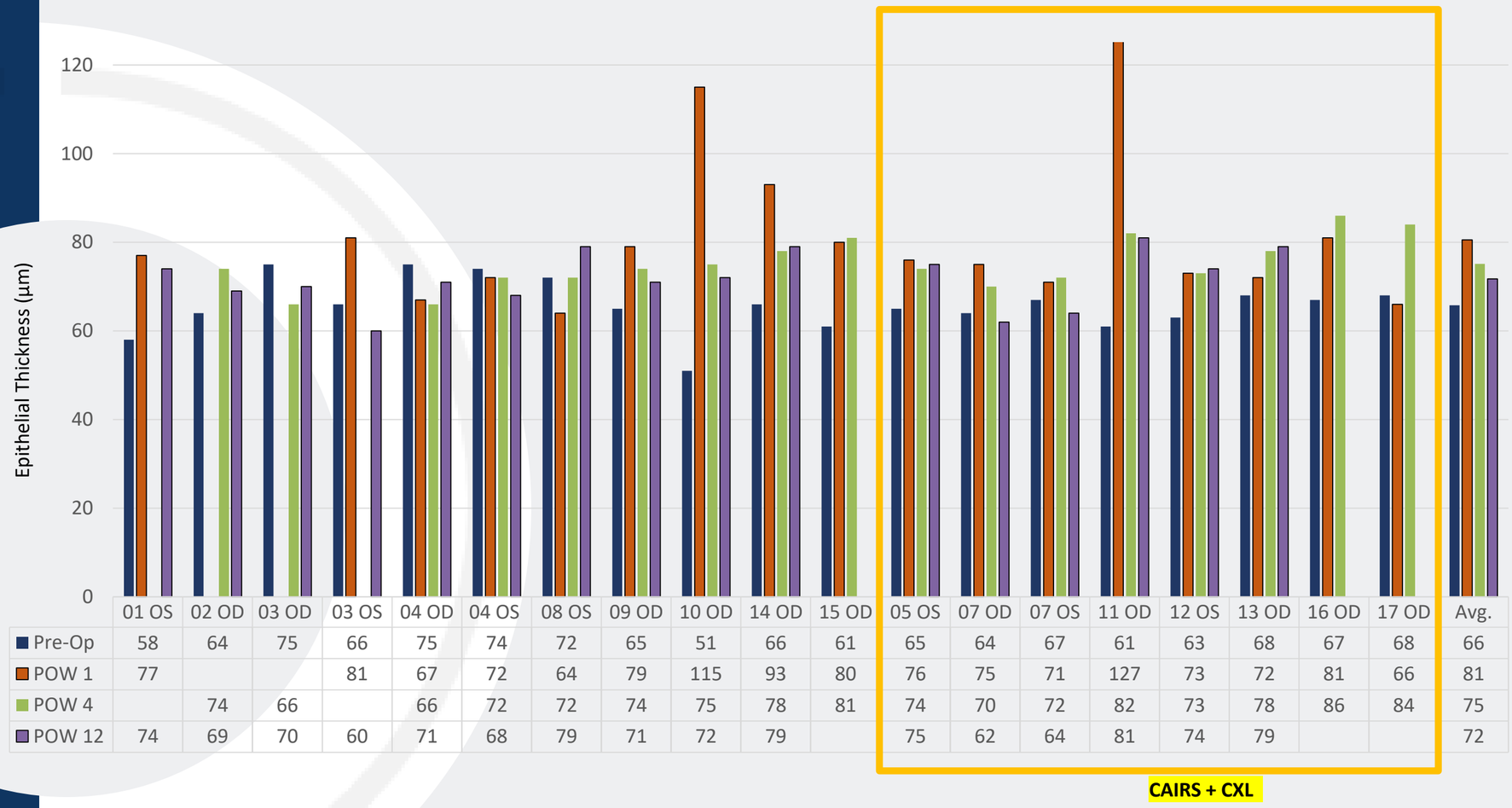
RESULTS:





Mann Whitney Thickest Epithelium	P-Value	Thickest Epithelium Average (um)
Pre-Op	-	66
Pre-Op vs POW 1	0.0002	81
Pre-Op vs POW 4	0.0002	75
Pre-Op vs POW 12	0.012	72

Figure 4. Thickest Epithelium Changes.

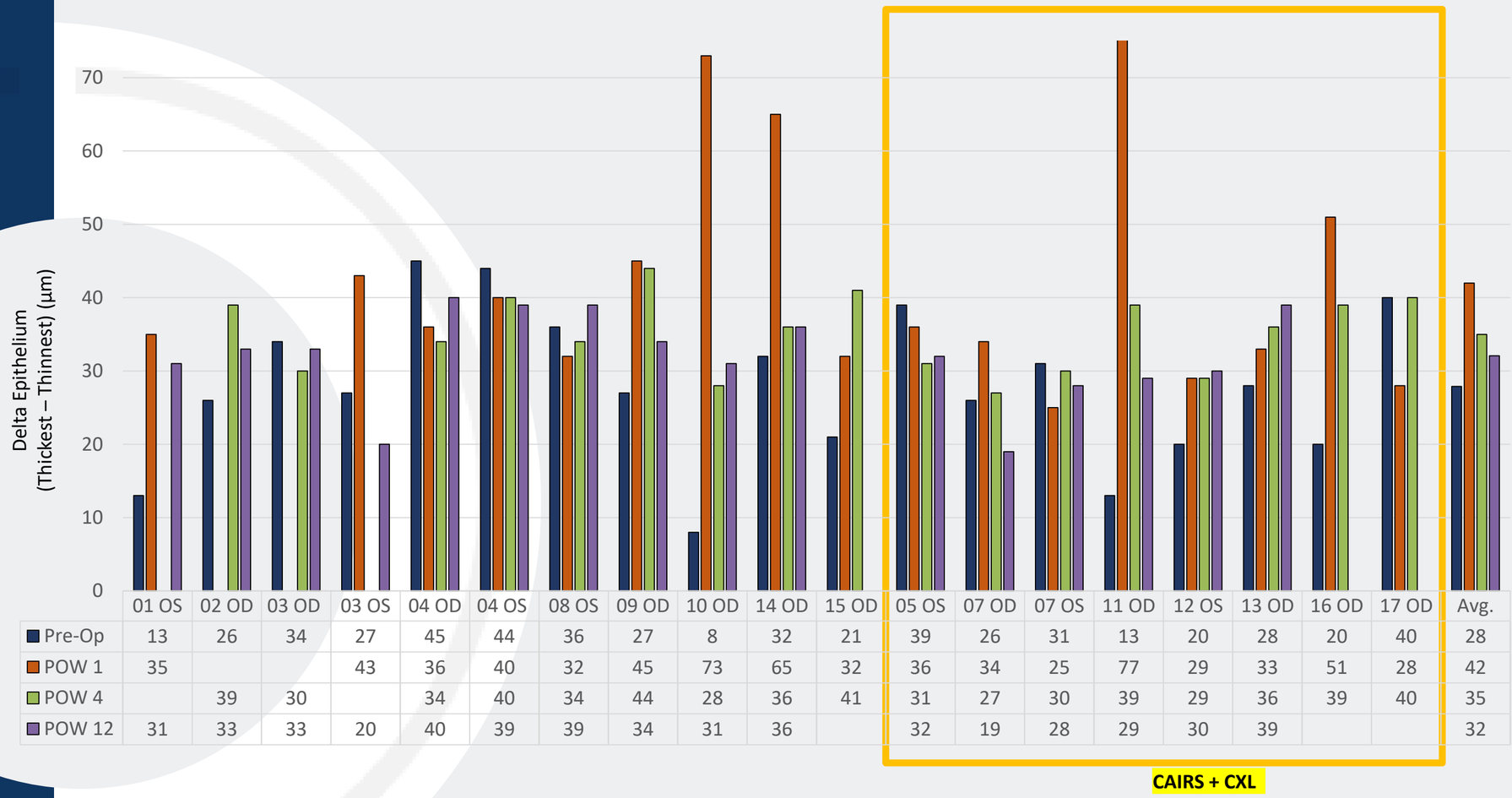


	01 OS	02 OD	03 OD	03 OS	04 OD	04 OS	08 OS	09 OD	10 OD	14 OD	15 OD	05 OS	07 OD	07 OS	11 OD	12 OS	13 OD	16 OD	17 OD	Avg.
Pre-Op	58	64	75	66	75	74	72	65	51	66	61	65	64	67	61	63	68	67	68	66
POW 1	77			81	67	72	64	79	115	93	80	76	75	71	127	73	72	81	66	81
POW 4		74	66		66	72	72	74	75	78	81	74	70	72	82	73	78	86	84	75
POW 12	74	69	70	60	71	68	79	71	72	79		75	62	64	81	74	79			72

Therefore, by post-op week 1, the epithelium is thicker, thereby causing a compensatory effect where the gutter effect increases the epithelium's capacity for masking.

RESULTS:

Figure 5. Delta Epithelium Changes.



	01 OS	02 OD	03 OD	03 OS	04 OD	04 OS	08 OS	09 OD	10 OD	14 OD	15 OD	05 OS	07 OD	07 OS	11 OD	12 OS	13 OD	16 OD	17 OD	Avg.
Pre-Op	13	26	34	27	45	44	36	27	8	32	21	39	26	31	13	20	28	20	40	28
POW 1	35			43	36	40	32	45	73	65	32	36	34	25	77	29	33	51	28	42
POW 4		39	30		34	40	34	44	28	36	41	31	27	30	39	29	36	39	40	35
POW 12	31	33	33	20	40	39	39	34	31	36		32	19	28	29	30	39			32

Mann Whitney Delta Epithelium	P-Value	Thickest Epithelium Average (um)
Pre-Op	-	28
Pre-Op vs POW 1	0.0053	42
Pre-Op vs POW 4	0.032	35
Pre-Op vs POW 12	0.19	32

Therefore, there is a trend towards the epithelium thinning out once again. As such, the gutter effect becomes less intense.

RESULTS:

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When is remodeling complete?

Mann Whitney Thickest Epithelium	P-Value
POW 1 vs POW 4	0.73
POW 1 vs POW 12	0.084
POW 4 vs POW 12	0.15

Therefore, by POW 1, the epithelium is already as thick as it is going to get, statistically speaking.

- *Quantitatively, however, the epithelium thickness pattern is still remodeling, as demonstrated by Figures 3-5.*

Does CXL slow down the remodeling process?

Mann Whitney Thickest Epithelium CAIRS vs. CAIRS + CXL	P-Value
POW 1	0.944
POW 4	0.289
POW 12	0.779

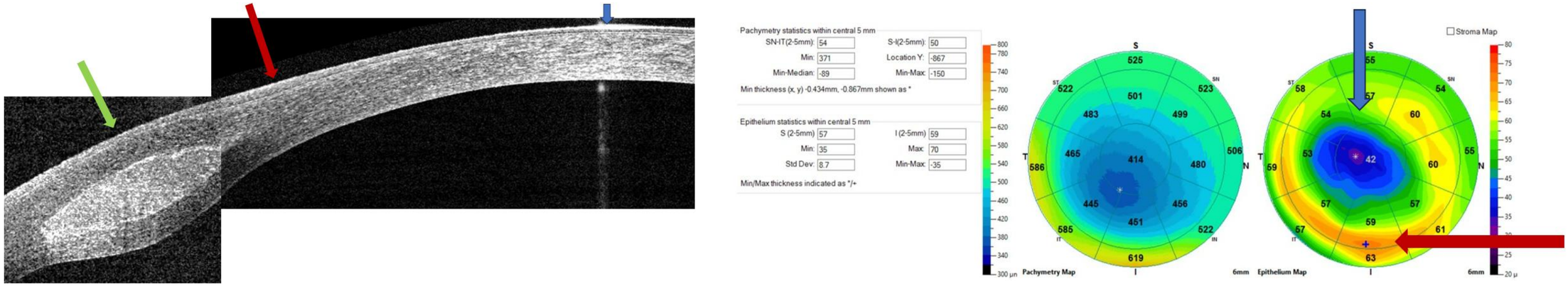
Therefore, the thickest epithelium was not different at any time point.

- *Hence, CXL does not slow down the remodeling process.*
  - *Guarded conclusion – analysis limited by small case volume.*

RESULTS:

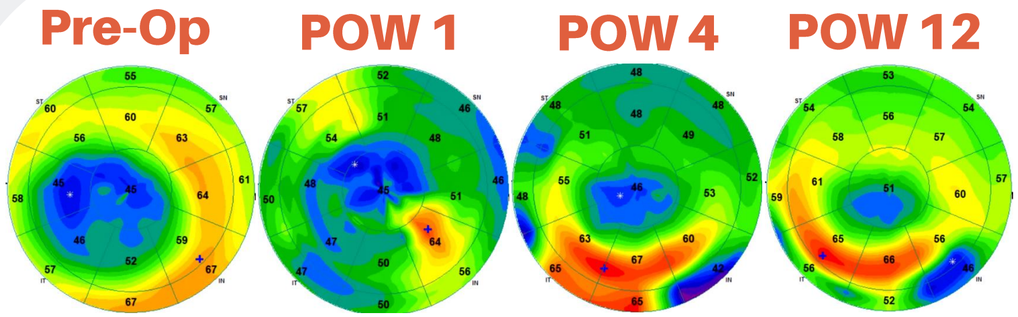
Figure 6. Tomography post-CAIRS implantation.

"Gutter" = increased epithelial thickness = more regularized surface



After CAIRS implantation, the magnitude of the thinnest location did not change (p-value 0.472). However, the magnitude of the thickest location increased (p-value 0.006).

Why is CAIRS important:

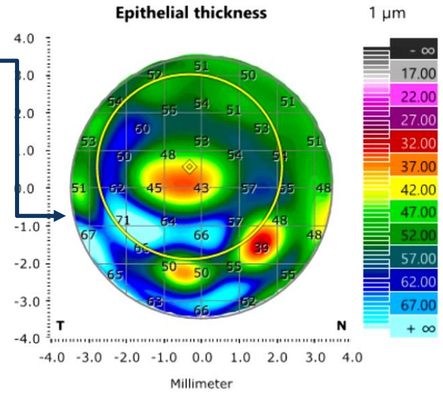


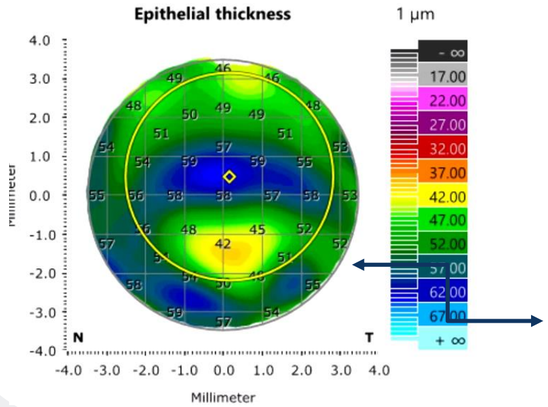
6 mm scan

Both 3 scans months post-op

8 mm scan

- Demonstrates guttering effect with a thick epithelium in the gutter and a thin epithelium over the top of the CAIRS segment and apex.





Patient's Contralateral Eye:

- No CAIRS segment – epithelial thinning over apex and thickening at base of cone

By examining the change in epithelium thickness, we find increased remodeling after CAIRS.

Having a gutter central to the CAIRS implant allows the epithelium to thicken greater than it would otherwise, further regularizing the cornea.

CONCLUSIONS:

1. The epithelial compensation pattern changed significantly after CAIRS implantation.

2. The thickest location was found in the space between the corneal apex and the apex of the CAIRS implant.

3. A greater magnitude of epithelial masking was present post-op.

4. Attention to epithelial patterns is crucial for any subsequent excimer ablation and appears to be stable by 3 months.

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References in Notes section below

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