Corneal Density in Patients with Progressive Keratoconus After Accelerated Corneal Collagen Cross-linking: 18-month Follow-up

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Introduction

Accelerated corneal cross-linking (A-CXL) procedure aims to halt the progression of keratoconus[1]. Nonetheless, the long-term effects of A-CXL on post-operative corneal transparency are relatively unknown. Corneal densitometry is a non-invasive method used to evaluate it and is thought to reflect corneal health[2]. Our aim was to assess the 18-month changes in corneal densitometry values after epi-off A-CXL in patients with progressive keratoconus (PKC).

Methods

This is a retrospective observational study, where charts of 16 eyes of 15 patients with PKC, who received epi-off A-CXL from 2016 to 2018 at Department of Ophthalmology, Hospital of Lithuanian University of Health Sciences Kauno Klinikos (Kaunas, Lithuania), were reviewed.

Uncorrected distance visual acuity (UDVA), best corrected visual acuity (BCVA), parameters of corneal topography (CT) and densitometry (CD) (Figure 1) were evaluated at the baseline and 3, 6, 12 and 18 postoperative months (PM) after epi-off A-CXL using Pentacam ®. CD was measured in total thickness (TT) and anterior (AL), middle (ML) and posterior layers (PL) of the corneal stroma in 4 annular diameters: 0-2 mm (Ø0-2mm), Ø2-6mm, Ø6-10mm and Ø10-12mm (Figure 2).

The statistical analysis was performed using IBM SPSS v. 25.0 software.

Results

1. UDVA, BCVA:

- We found no statistically significant changes in UCVA or BCVA over 18-month follow-up after epi-off A-CXL compared to the baseline results;

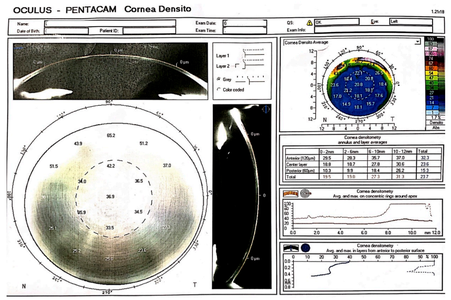


Figure 1. Pentacam ® corneal densitometry map.

		Baseline (N=16)		3 months (N=15)		6 months (N=8)		12 months (N=10)		18 months (N=6)	
		Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Anterior layer 120 µm	Annulus 0 – 2 mm	24.08 ± 2.68	19.9 – 30.9	38.51 ± 7.09	24.8 – 48.2	32.95 ± 5.59	28.8 – 44.2	33.38 ± 8.40	27.3 – 53.3	29.38 ± 5.40	24.2 – 39.8
	Annulus 2 – 6 mm	21.19 ± 1.71	18.7 – 25.8	29.23 ± 3.54	22.1 – 35.4	24.98 ± 2.28	22.9 – 30.1	23.83 ± 1.64	21.4 – 26.1	21.75 ± 1.26	19.7 – 23.5
	Annulus 6 – 10 mm	19.33 ± 3.61	13.9 – 29.1	20.55 ± 3.08	17.0 – 27.3	20.38 ± 3.20	16.7 – 26.8	19.53 ± 3.36	14.7 – 24.5	17.65 ± 1.35	16.1 – 20.1
	Annulus 10 – 12 mm	32.15 ± 12.49	12.6 – 57.6	30.99 ± 10.94	16.5 – 50.4	29.80 ± 11.14	20.7 – 53.3	29.65 ± 14.38	13.8 – 55.6	25.62 ± 6.76	14.6 – 34.4
Middle layer	Annulus 0 – 2 mm	15.51 ± 1.03	13.7 – 17.6	22.13 ± 3.21	17.1 – 26.0	17.79 ± 3.06	10.9 – 20.3	18.45 ± 2.77	16.5 – 25.7	17.55 ± 2.11	15.1 – 20.6
	Annulus 2 – 6 mm	13.43 ± 0.93	12.1 – 15.6	17.29 ± 2.79	13.9 – 25.2	14.96 ± 0.96	13.8 – 16.9	14.37 ± 1.22	12.9 – 17.2	13.7 ± 1.02	12.2 – 15.0
	Annulus 6 – 10 mm	13.33 ± 1.88	9.9 – 17.2	13.61 ± 1.79	11.6 – 17.2	14.04 ± 1.65	11.8 – 16.7	13.31 ± 2.03	10.1 – 15.7	12.62 ± 1.58	10.4 – 15.2
	Annulus 10 – 12 mm	19.81 ± 6.72	10.7 – 36.0	18.19 ± 4.75	11.9 – 28.6	20.69 ± 4.64	14.2 – 29.0	18.26 ± 7.40	10.9 – 32.7	16.47 ± 3.90	11.4 – 20.5
Posterior layer 60 µm	Annulus 0 – 2 mm	7.47 ± 1.30	5.8 – 10.3	9.84 ± 2.54	7.1 – 14.6	8.18 ± 1.27	6.1 – 10.1	8.78 ± 1.37	7.2 – 12.0	8.65 ± 1.04	7.1 – 9.9
	Annulus 2 – 6 mm	8.56 ± 0.87	6.1 – 9.6	10.59 ± 2.26	7.9 – 17.1	9.10 ± 1.12	7.3 – 10.7	9.31 ± 0.94	7.7 – 11.0	9.32 ± 1.56	6.9 – 11.3
	Annulus 6 – 10 mm	10.34 ± 1.75	6.8 – 12.6	10.63 ± 1.42	8.2 – 12.7	10.94 ± 1.58	8.4 – 12.7	10.67 ± 1.72	8.3 – 12.9	10.30 ± 1.50	8.2 – 12.8
	Annulus 10 – 12 mm	15.94 ± 4.86	7.0 – 24.9	15.00 ± 3.61	9.9 – 20.7	17.63 ± 3.36	12.4 – 22.2	14.48 ± 5.02	9.5 – 24.1	13.38 ± 3.44	8.7 – 16.8
Total thickness	Annulus 0 – 2 mm	15.7 ± 1.50	13.2 – 18.0	23.50 ± 3.79	16.7 – 28.9	20.06 ± 2.27	17.6 – 24.5	18.17 ± 3.34	10.0 – 23.0	18.52 ± 2.53	16.1 – 23.4
	Annulus 2 – 6 mm	14.39 ± 0.96	12.9 – 16.7	19.01 ± 2.38	15.4 – 23.9	16.35 ± 1.26	14.9 – 19.0	15.83 ± 1.14	14.3 – 18.1	14.94 ± 1.19	13.2 – 16.4
	Annulus 6 – 10 mm	14.33 ± 2.31	10.3 – 19.6	15.01 ± 1.99	12.6 – 18.9	15.09 ± 2.07	12.5 – 18.7	14.50 ± 2.30	11.0 – 17.6	13.53 ± 1.47	11.6 – 16.1
	Annulus 10 – 12 mm	22.61 ± 7.76	11.4 – 39.4	21.45 ± 6.02	13.2 – 33.1	22.70 ± 6.07	17.3 – 34.8	20.79 ± 8.70	11.7 – 36.9	18.50 ± 4.34	11.9 – 23.9

Table 1. Baseline and postoperative18-month follow-up corneal densitometry values after epi-off A-CXL.

P values					
		Baseline vs. 3 months	Baseline vs. 6 months	Baseline vs. 12 months	Baseline vs. 18 months
Anterior layer 120 µm	Annulus 0 – 2 mm	**P = 0.001**	**P = 0.012**	**P = 0.005**	**P = 0.028**
	Annulus 2 – 6 mm	**P = 0.001**	**P = 0.012**	**P = 0.007**	P = 0.075
	Annulus 6 – 10 mm	P = 0.090	P = 0.866	P = 0.779	P = 0.596
	Annulus 10 – 12 mm	P = 0.532	P = 0.263	P = 0.683	P = 0.082
Middle layer	Annulus 0 – 2 mm	**P = 0.001**	**P = 0.042**	**P = 0.005**	**P = 0.028**
	Annulus 2 – 6 mm	**P = 0.001**	**P = 0.012**	**P = 0.008**	P = 0.400
	Annulus 6 – 10 mm	P = 0.060	P = 0.944	P = 0.722	P = 0.686
	Annulus 10 – 12 mm	P = 0.363	P = 0.944	P = 0.878	P = 0.527
Posterior layer 60 µm	Annulus 0 – 2 mm	**P = 0.001**	P = 0.208	P = 0.113	P = 0.116
	Annulus 2 – 6 mm	**P = 0.002**	P = 0.441	P = 0.138	P = 0.248
	Annulus 6 – 10 mm	P = 0.064	P = 0.610	P = 0.313	P = 0.293
	Annulus 10 – 12 mm	P = 0.155	P = 1.000	P = 0.878	P = 0.500
Total thickness	Annulus 0 – 2 mm	**P = 0.001**	**P = 0.012**	**P = 0.049**	**P = 0.028**
	Annulus 2 – 6 mm	**P = 0.001**	**P = 0.012**	P = 0.120	P = 0.116
	Annulus 6 – 10 mm	P = 0.100	P = 0.574	P = 0.646	P = 1.000
	Annulus 10 – 12 mm	P = 0.460	P = 0.674	P = 0.878	P = 0.528

Table 2. Differences in corneal densitometry between follow-up times. P-values below 0.05 (bold) were considered statistically significant.

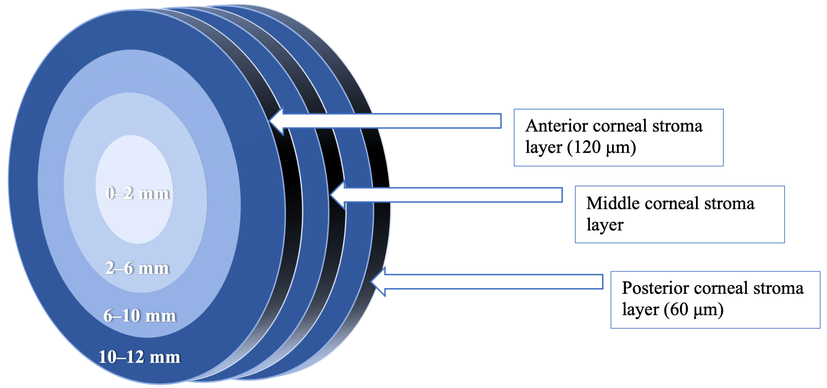


Figure 2. Different corneal stromal layers and concentric zones.

Results

2. CT:

- There was a statistically significant decrease in the mean thinnest corneal thickness to 447.6 ± 37.4 µm at 3 months compared to the baseline 472.1 ± 39.6 µm (P=0.003);
- We found no statistically significant changes in K_{max} over 18-month follow-up after A-CXL compared to the baseline results.

3. CD (Table 1 and 2):

AL and **ML**

- There was a statistically significant increase of the mean CD values in both, AL and ML over Ø 0-2mm, Ø 2-6 mm at 3, 6 and 12 PM and over Ø 0-2 mm at 18 PM compared to the baseline results;

PL

- The mean CD values were statistically significantly higher at 3PM over Ø 0-2mm, Ø 2-6 mm in respect to the baseline results;

TT

- There was a statistically significant increase of the mean CD values over Ø 0-2mm, Ø 2-6 mm at 3, 6 PM and Ø 0-2mm at 12, 18 PM in relation to the baseline results;

- We found no statistically significant changes in any of the layers of the corneal stroma over Ø 6-10mm and Ø 10-12mm in a period of 18-month follow-up after epi-off A-CXL.

Conclusion

The values of corneal densitometry remain increased over the postoperative period of 18 months after epi-off A-CXL.

References

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