

Corneal Allogenic Intrastromal Ring Segments: a literature review



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Introduction

- The most common conditions associated with corneal ectasia include keratoconus, pellucid marginal degeneration, and post-refractive surgery ectasia.
- The Current management strategies for corneal ectasia are:
  - Stabilizing the cornea with cross-linking (CXL)
  - Improving the visual acuity
- Intrastromal corneal ring segments (ICRS) can reshape the cornea, effectively reducing astigmatism and flattening the steep areas.
- Synthetic ICRS have shown efficacy in reshaping the cornea, although complications like extrusion and infection can occur.
- Corneal transplantation can offer significant visual improvement but carries risks as graft rejection, infection, and prolonged recovery time.
- Corneal Allogenic Intrastromal Ring Segments (CAIRS) is an innovative treatment for corneal ectasia.
- The ring segments are crafted from donor corneal stromal tissue and embedded into stromal channels within the patient's cornea.
- CAIRS is a natural alternative to synthetic ICRS that enhances corneal stability and reduces astigmatism and associated risks.
- They provide a less invasive option when other treatments are ineffective.

Purpose

- CAIRSs can be customized in terms of size and shape to better fit individual patient anatomy and disease progression, allowing for a more tailored approach to treatment.
- CAIRSs is an evolving technique lacking standardized criteria, resulting in variability in surgical approaches and patient selection.

Methods

- A literature search was conducted, including only studies with 20 or more eyes and a minimum follow-up of 6 months.

Results

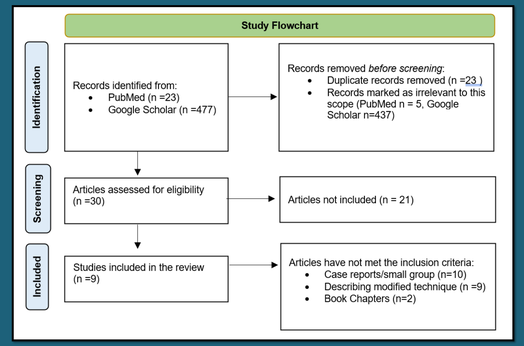
- Nine studies were found to be eligible, published between 2018-2024.
- A total of 303 patients and 389 eyes, of which 102 eyes had CXL, were included with a mean follow-up period between 6 and 23 months.

Primary Outcome:

- The mean pre-operative uncorrected distance visual acuity (UCDVA) was 0.83 ±0.15 logMAR; this improved to 0.40 ± 0.08 logMAR ($p = 0.01$).
- Four studies reported the percentage of patients experiencing an increase in UDVA, with a mean improvement rate of 84.9% ±11.4

Secondary Outcomes:

- CDVA showed notable enhancement, with mean values improving from 0.52 ± 0.22 to 0.19 ± 0.09 logMAR ($p = 0.01$).
- SE improved significantly from the mean value of -7.09 D to -2.34 D ($p < 0.01$).
- Mean K-max decreased from 57.8 ± 1.09 to 53.57 ± 2.66 ($p < 0.01$) and the mean K-mean decreased from 49.27 ± 0.28 to 45.30 ± 1.46 ($p < 0.01$).
- The mean K1 value decreased from 47.30 ± 0.51 D pre-operatively to 43.31 ± 0.90 D postoperatively, reflecting an average reduction of 3.99 D ($p < 0.01$).
- Similarly, the mean K2 value decreased from 51.49 ± 0.24 D pre-operatively to 47.05 ± 1.48 D postoperatively, corresponding to an average reduction of 4.44 D ($p < 0.01$).



Complications

- No major complications were reported across all studies.
- one case of graft dislocation towards the implantation site and dehiscence at the tunnel entrance; this patient's graft was repositioned successfully.
- One patient complained of halo and glare at night postoperatively.
- Two studies reported one patient who lost one line of CDVA three months postoperatively.

Conclusions

- CAIRSs serve as an alternative to synthetic ICRSs and even corneal transplantation in some cases.
- They represent a safe, effective, and biocompatible promising advancement in corneal ectasia management to improve visual acuity and corneal topography with minimal complications.

Details of included studies

Study	Num of Eyes	Mean age (years)	Follow-up period (months)	Preoperative UDVA (logMAR)	Postoperative UDVA (logMAR)	Preoperative CDVA (logMAR)	Postoperative CDVA (logMAR)	Preoperative Kmax (Diopters)	Postoperative Kmax (Diopters)	Preoperative Mean K (Diopters)	Postoperative Mean K (Diopters)
Jacob S, 2018	24	N/A	11.58 ±3.6	0.65±0.79	0.443 ±0.65	0.22 ±0.67	0.1 ±0.72	55.35	52.55	49.58	48.1
Bteich Y, 2023	52	31.2 ±13.6	6.9 ±5.2	0.97 ±0.47	0.56 ±0.25	0.56 ±0.19	0.22 ±0.21	58.09	52.33	48.92	44.32
Kirgiz A, 2024	23	29.3± 7.2	6	1.09 ±2	0.397 ±1.3	0.6 ±0.95	0.16 ±1.04	57.65	46.96	49.86	42.4
Nacaroglu SA, 2023	65	29.5± 7.3	12	0.91 ±0.5	0.36 ±0.25	0.87 ±0.2	0.36 ±0.15	59.2	55.63	49.23	45.23
Yucekul B, 2024	30 With CXL	29 (median)	6	0.69 ±0.76	0.35 ±0.55	0.55 ±0.69	0.26 ±0.58	57.22	54.11	49.46	46.34
	37 without CXL	24 (median)		0.76 ±0.79	0.3 ±0.65	0.5 ±0.74	0.16 ±0.16	58.38	55.66	49.11	44.45
Haciagaoglu S, 2023	44	30.32± 7.43	6	0.69 ±0.74	0.34 ±0.58	0.53 ±0.69	0.25 ±0.58	57.56	55.4	49.01	45.71
Jacob S, 2023	32	N/A	12 or more	0.66 ±0.95	0.32 ±0.61	0.11 ±0.72	0.05 ±0.76	58.9	54.95	49.07	45.63
Bteich Y, 2024	20	N/A	12	0.89 ±0.33	0.52± 0.16	0.57 ±0.18	0.15± 0.18	57.21	52.85	49.3	45.23
Feyza F, 2024	49	29.04± 8.13	23± 13.46	0.96± 0.5	0.41± 0.34	0.72± 0.47	0.22± 0.19	58.51	55.31	49.17	45.68

UDVA = uncorrected distance visual acuity; CDVA = corrected distance visual acuity; Kmax = maximum keratometry; Mean K = mean keratometry.

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