Femtosecond Laser-Assisted CAIRS Allogenic ring segments for Keratoconus

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Abstract

This study evaluates the visual , topographic & refractive efficacy of femtosecond laser Corneal Allogenic Intrastromal Ring Segments (CAIRS) for Keratoconus in one of the first UK series.

Methods: Data were analysed from 18 patients treated with CAIRS since 2022 , with minimum 3 month follow up. Segments and host channels were created using femtosecond laser. ASOCT topographic parameters included mean keratometry (Mean K), keratometric cylinder (KCYL), lower-order aberrations (LOA), higher-order aberrations (HOA). Refractive astigmatism (Cyl) and best corrected vision (BCVA) were assessed

Results: Vision improved overall from mean LogMAR BCVA 0.54 preop to 0.38 postop (P=0.03) Mean K flattened significantly from 49.27D to 46.57D ($p < 0.005$) and KCYL reduced from 5.29D to 4.15D ($p = 0.003$). Topographic reductions in LOA (from 5.82um to 4.27um, $p < 0.001$) and HOA (from 1.58um to 1.2, $p = 0.005$) were significant. Refractive astigmatism showed improvement from -4.29D to -4.0D , though this change was not statistically significant ($p = 0.104$).

Conclusions: This small study highlights the effectiveness of CAIRS, particularly with the use of femtosecond laser technology, in enhancing corneal metrics and thus vision in keratoconus patients. While changes in refractive astigmatism were not statistically significant, overall improvements in keratometry, aberrations, and ASOCT topographic parameters underscore the procedure's potential ,particularly with further nomogram refinement and firther studies.

Introduction

The use of allogenic corneal ring segments as CAIRS was introduced by Soosan Jacob, and has rapidly become recognized as a valuable treatment modality for keratoconus.

Compared to conventional PMMA intracorneal ring segment , there is less risk of extrusion , and the segments can be customized much more easily .

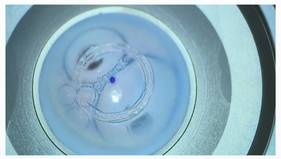
Although originally described with mechanical trephination , the use of femtosecond laser simplifies the preparation , and allows considerable customization of segment dimensions.

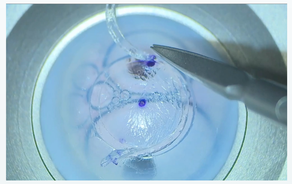
In our unit we have been performing CAIRS since

Femtosecond Laser & Surgical Technique

Donor Corneas were mounted on artificial anterior chamber .The epithelium was completely removed .

The femtosecond laser was programmed to cut segments with 6mm centre diameter, and 1000um width. The thickness of the segment (anteropsterior) was customised , in less aberrated corneas a thickness of 400um was used, with full thickness segments in more advanced cases





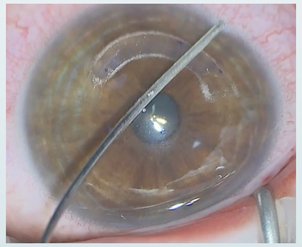
The segments could be easily removed in all cases . The angular dimension of the segment was prepared in the operating theatre manually, with segments varying from 100 to 180 degree ARC depending on the preoperative topography using a modified nomogram

The Host channel was prepared using the same femtosecond laser platform

The channel was usually at 250 um depth , 1200um wide and centered at 6mm zone.

The arc length used varied from 100 to 200 degree, and was made 20 degree longer than the intended segment to prevent gape of the entrance wounds





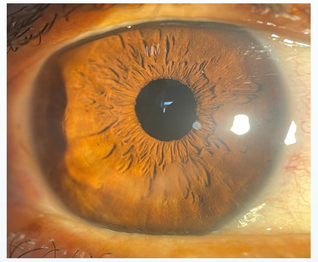
This could then be used to insert the CAIRS segment in a simple single movement

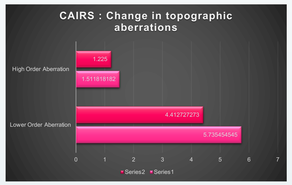
All cases were completed without complication

Results

Eyes settled very quicky postoperatively.

We found that complete transparency of the cornea was retained in most cases , and compared to published results with pre-prepared segments appear to less opacity / haze . However future studies will be required to confirm this finding .





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No patient lost more than 1 line of BCVA , and the majority (87% has at least 1 line of improvement)



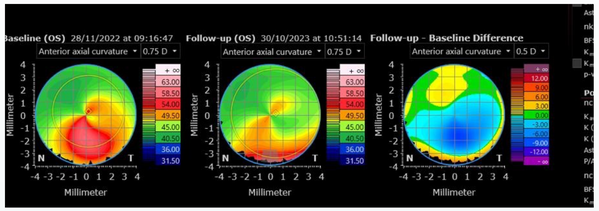
Summary

We have performed all femtosecond CAIRS in our unit since 2022

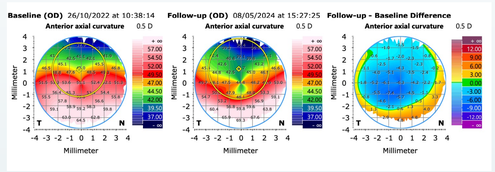
Initial results were limited by caution and the absence of nomograms , but we continues to evolve and improve the procedure .

However even limited treatments offer useful visual improvements, striking in many cases

Examples



Typical topographic change following CAIRS
The patients vision improved by more than 2 lines following the procedure



Patient with severe disease . Unable to correct vision despite PRK/CXL .
Vision improved from 3/60 best corrected to 6/9 corrected after CAIRS

References

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Bteich Y, Assaf JF, Mrad AA, Jacob S, Hafezi F, Awwad ST. Corneal Allogenic Intrastromal Ring Segments (CAIRS) for Corneal Ectasia: A Comprehensive Segmental Tomography Evaluation. J Refract Surg. 2023 Nov;39(11):767-776. doi: 10.3928/1081597X-20231011-01. Epub 2023 Nov 1. PMID: 37937759.