Objective
Cyclotorsional eye movements can occur when patients change position from seated to supine position. This postural-related change is even more pronounced under monocular viewing conditions. As preoperative LASIK assessments are typically done in the seated upright position and laser ablation is done with the patient lying supine, pupil shift and eye cyclotorsions can occur, leading to misalignment of ablation even before the ablation begins. Furthermore, the eye continues to move in all directions (X, Y, Z axes and rotational) throughout the procedure, resulting in more misalignments of treatment, especially in astigmatic cases. The effectiveness of astigmatism correction decreases significantly with the increase in axis and magnitude of misalignment. Worse still, higher order aberrations could be induced when the misalignment is more than 2 degrees.

Most of the currently used cyclotorsional eye trackers track static postural-related changes but few can track for the dynamic cyclotorsional eye movements. The Advanced Control Eye tracker, Baush & Lomb (ACE®, B & L), which can track both static and dynamic cyclotorsions during LASIK, was used in this study. The aims of this study are:

Primary aims:
1. To evaluate the safety and predictability of ACE®
2. To assess the efficacy of ACE® in the correction of astigmatism

Secondary aims:
1. To study the magnitude and rotation angle of cyclotorsion of static/ postural cyclotorsion
2. To study the magnitude and direction of dynamic cyclotorsion during laser ablation

Methods
This is a retrospective case-notes review of consecutive cases of myopic astigmatic Intralase-Tissue Saving LASIK utilizing the Zyoptix® 217z100 (B&L) excimer laser, performed between January 2007 and March 2009 utilizing full static and dynamic ACE®, by 3 surgeons in our centre.

All patients underwent standard pre-operative LASIK assessments, including manifest refraction, cornea topography, pachymetry, intracoronal pressure measurements, Zywave analysis and a full eye examination. Iris registration was captured using Zywave aberometer. Intraoperatively, the static eye tracker was engaged after flap cut, but before flap lift. Dynamic rotational eye tracker (DRET) was used throughout laser ablation. The range of dynamic cyclotorsional movements were recorded.

All eyes with astigmatic correction of 0.50D or more were included in the study. All study eyes completed 3 month follow-up review visits. Pre- and post-operative refractive data was collected and analyzed, using Alpins method of vector analysis.

Analysis of demographic data was done using SPSS for Windows version 16. The safety, predictability and efficacy of the surgical outcome of ACE® was analyzed.

Results
Total no of eyes: 126 (63 patients)

Demographics: (refer to Fig. 1)

Outcomes:
All patients had uneventful surgery
All eyes had pre-operative BCVA 6/6
All eyes achieved post-op BCVA 6/6
No eyes lost BCVA.

3M Predictability: (refer to Fig. 2 & 3)
3M Refractive outcome: (refer to Fig. 4 & 5)

Cyclotorsional changes:
Upright to supine: 12% had > ± 5° (refer to Fig. 6)
Dynamic cyclotorsion during laser ablation (refer to Fig. 7 & 8):
15% magnitude >15%, 14% average position ± 5° misaligned

Discussion
Analysis of study results:
Scatter plots (refer to Fig. 9, 10 & 11) and individual plots (refer to Fig. 12 & 13) illustrating targeted and surgically induced astigmatism. These were found to be very closely matched with small differences between them.

Conclusions
(1) Precise alignment of laser ablation is of fundamental importance in ensuring good visual outcome
(2) 12% had more than 5° of postural cyclotorsion
(3) 15% had more than 5° of dynamic cyclotorsion during laser ablation
(4) ± 5° axis error would result in 17% undercorrection

Therefore, both static and dynamic cyclotorsion correction are essential to prevent misalignment of laser ablation, especially for astigmatic wavefront and topography-guided treatments. Cyclotorsional compensation should be an integral part of refractive surgery. Our study found ACE® to be convenient, safe and effective for alignment of astigmatic axis during LASIK.

References
(4) Guarino A, Willmore DR, Cox IG. Effect of rotation and translation on the expected benefit of an ideal method to correct the eye’s higher-order aberrations.

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