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EVALUATION OF ANTERIOR SEGMENT CHANGES AFTER LASER PERIPHERAL IRIDOTOMY AND TRABECULECTOMY IN PRIMARY ANGLE CLOSURE GLAUCOMA USING SIRIUS SCHEIMPFLUG IMAGING

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ABSTRACT

Purpose: To evaluate changes in anterior segment morphology following laser peripheral iridotomy (LPI) and trabeculectomy in primary angle closure glaucoma (PACG) using Sirius Scheimpflug imaging. **Methods:** In this prospective study, PACG patients undergoing LPI and trabeculectomy were imaged pre- and post-procedure using the Sirius Scheimpflug system. Anterior segment parameters including anterior chamber depth (ACD), anterior chamber volume (ACV), anterior chamber angle (ACA), iris curvature (I-Curv), and lens vault (LV) were analyzed and compared. **Results:** 72 eyes of 36 PACG patients were analyzed. At 1 month post-LPI, there was significant widening of ACA ($p<0.001$), flattening of I-Curv ($p=0.002$), and lowering of LV ($p<0.001$) with no change in ACD or ACV. After trabeculectomy, ACD and ACV increased significantly ($p<0.001$), along with further ACA widening ($p=0.03$) and I-Curv flattening ($p=0.01$). LV remained reduced. **Conclusions:** Sirius imaging allows quantitative assessment of anterior segment changes after LPI and trabeculectomy in PACG. LPI induced morphologic changes consistent with iris profile flattening and angle widening. Trabeculectomy additionally increased anterior chamber depth and volume. Scheimpflug imaging enables understanding of biomechanical effects of glaucoma surgery.

KEYWORDS

Sirius imaging, Laser Peripheral Iridotomy, Trabeculectomy.

INTRODUCTION

Primary angle closure glaucoma (PACG) is a major cause of irreversible blindness worldwide. It is estimated to affect over 20 million people, accounting for at least 50% of glaucoma cases in Asia [1]. PACG results from progressive closure of the anterior chamber angle by the peripheral iris, leading to impaired aqueous outflow, increased intraocular pressure (IOP), optic nerve damage and visual field loss. Prompt diagnosis and treatment is aimed at opening the angle and lowering IOP to prevent further vision loss.

Laser peripheral iridotomy (LPI) is the initial treatment to eliminate pupillary block, the primary mechanism of angle closure, by creating a full-thickness opening in the iris. This equalizes pressure between the posterior and anterior chambers, pulling the iris periphery backwards to open the angle. Trabeculectomy is often subsequently performed for IOP control, creating a new drainage channel to enhance aqueous outflow. While clinical outcomes have been well studied, anterior segment changes induced by these angle surgery procedures have not been comprehensively characterized.

Advances in imaging technologies like Scheimpflug photography now allow objective quantification of anterior segment anatomy. The Sirius Scheimpflug system uses a rotating camera to capture cross-sectional images of the anterior segment, with advanced analysis software generating various structural parameters [2]. Prior smaller studies have evaluated anterior chamber changes after LPI and trabeculectomy using Scheimpflug imaging [3,4]. However, comprehensive analysis of how iris profile and lens position are affected has been limited.

In this study, we aimed to evaluate changes in anterior segment morphology following LPI and trabeculectomy in PACG using the Sirius Scheimpflug system. Defining these anatomical effects can aid in understanding the biomechanical mechanisms of glaucoma surgery.

METHODS

This was a prospective, observational study carried out at SMS hospital Jaipur. Consecutive PACG patients undergoing LPI and trabeculectomy were recruited.

The diagnosis of PACG was based on at least three of the following criteria: 1) narrow iridocorneal angle (≤20°) assessed using gonioscopy; 2) glaucomatous optic neuropathy; 3) IOP ≥21 mmHg; and 4) peripheral anterior synechiae over at least 180° of the angle circumference. Eyes with secondary angle closure disorders were excluded.

All patients underwent LPI with an Nd:YAG laser, followed by trabeculectomy with mitomycin-C by a single surgeon within 1-2 months. LPI was considered successful by documentation of a patent iridotomy and deepening of the anterior chamber angle. Trabeculectomy was done in superior bulbar conjunctiva, with scleral flap and peripheral iridectomy. Postoperative care included steroid and antibiotic eye drops.

Anterior segment imaging was performed with the Sirius Scheimpflug system (CSO, Italy) pre-procedure, 1 month after LPI, and 1 month after trabeculectomy. The patient was seated with chin on chinrest and asked to fixate on a target. Three high quality scans were obtained and analyzed by a single observer masked to clinical data using inbuilt Phoenix software. Parameters recorded included:

- Anterior chamber depth (ACD): Axial distance from endothelium to anterior lens surface
- Anterior chamber volume (ACV): Volume bounded by cornea, iris, and lens
- Anterior chamber angle (ACA): Angle between iris and cornea at 500 µm anterior to scleral spur
- Iris curvature (I-Curv): Quantified using radius of iris arc from pupillary to peripheral edge
- Lens vault (LV): Maximum perpendicular distance between anterior pole of lens and horizontal line joining angle recesses

Statistical analysis was performed using SPSS software. Paired t-test and Wilcoxon signed-rank test were used for pre- and post-procedure comparision of parameters. $p<0.05$ was considered statistically significant.

RESULTS

A total of 72 eyes of 36 PACG patients (25 females, 11 males) were analyzed. Mean age was 57.8 ± 6.2 years. By 1 month post-LPI, there was significant widening of the anterior chamber angle from a mean of 18.7° to 34.2° ($p<0.001$). The iris curvature flattened significantly from a mean radius of 6.41 mm to 6.92 mm ($p=0.002$). There was also significant lowering of lens vault from 897 µm to 810 µm ($p<0.001$). However, anterior chamber depth and volume did not show significant change after LPI.

Following trabeculectomy, anterior chamber depth increased significantly from 2.60 mm to 3.21 mm ($p<0.001$). Similarly, anterior chamber volume increased from 97.5 mm3 to 158 mm3 ($p<0.001$). There was further widening of the anterior chamber angle to a mean of 40.1° ($p=0.03$ compared to post-LPI state). Iris curvature continued to flatten with radius increasing to 7.22 mm ($p=0.01$). Lens vault remained reduced from baseline at 802 µm post-trabeculectomy, but not significantly changed from post-LPI.

DISCUSSION

In this study, we utilized Sirius Scheimpflug imaging to evaluate changes in anterior segment morphology following laser peripheral iridotomy and trabeculectomy in primary angle closure glaucoma. To

our knowledge, this is the first study to comprehensively analyze modifications in iris contour and lens vault in addition to anterior chamber parameters after these procedures.

We found that LPI induced significant flattening of iris curvature and lowering of lens vault, along with anterior chamber angle widening. This confirms that LPI successfully retracts the midperipheral iris away from the angle to relieve pupillary block. The reduction in lens vault also suggests the entire iris-lens diaphragm shifts posteriorly after LPI, as proposed by Quigley et al [5].

Trabeculectomy was associated with further deepening of the central anterior chamber. This posterior pressure gradient likely enhanced iris flattening and sustained angle opening. The persistently reduced lens vault implies permanent weakening of anterior zonules, which may facilitate long-term angle opening by allowing the lens-iris plane to move backwards more easily.

Our findings are consistent with and expand upon previous studies evaluating anterior chamber changes after LPI and trabeculectomy using ultrasound biomicroscopy (UBM) and Scheimpflug imaging. UBM studies have shown trabeculectomy causes anterior shifting of the ciliary body-scleral spur junction, with associated iris flattening and angle widening [6].

Smaller case series using Pentacam Scheimpflug imaging have similarly reported increased anterior chamber depth and angle widening post-LPI and trabeculectomy [7,8]. However, comprehensive analysis of dynamic iris and lenticular effects were not described. By quantifying changes in iris curvature and lens vault, our study provides further insight into the mechanisms underlying these procedures.

A key strength of our study was the use of Sirius Scheimpflug imaging, which provides superior image quality and repeatability compared to previous Scheimpflug systems [9]. The ability to objectively measure various anterior segment parameters is valuable for analyzing effects of angle surgeries. Potential limitations include shorter follow-up duration and lack of gonioscopic correlation with imaging changes.

CONCLUSIONS

Sirius Scheimpflug imaging enables quantitative assessment of anterior segment modifications induced by LPI and trabeculectomy in PACG. The increase in anterior chamber angle and flattening of peripheral iris after LPI signifies posterior movement of the mid-peripheral iris confirming the relief of pupillary block. Reduction in lens vault also suggests the Iris-lens diaphragm shifts posteriorly as a unit after LPI.

Trabeculectomy additionally causes deepening of the central anterior chamber and volume expansion, allowing the Iris-lens diaphragm to move further back. The sustained reduction in lens vault implies permanent weakening of anterior zonules, which may facilitate long-term angle opening.

This study demonstrates the ability of Scheimpflug imaging to objectively describe anterior segment anatomical changes reflecting the mechanisms of action of angle surgery in PACG. Defining these effects can help enhance surgical techniques and outcomes. Larger studies correlating imaging changes with IOP reduction are needed to further establish clinical utility.

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