# Anterior Chamber OCT Changes Following Penetrating Keratoplasty

A thesis
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By

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| **AC** | **Anterior chamber** |
| **ACA** | **Anterior Chamber Angle** |
| **ANSI** | **American National Standards Institute** |
| **AOD** | **Angle Opening Distance** |
| **ASOCT** | **Anterior Segment Optical Coherence Tomography** |
| **CF** | **Counting Finger** |
| **GON** | **Glaucomatous Optic Neuropathy** |
| **HM** | **Hand Motion** |
| **I** | **Inferior** |
| **IOP** | **Intraocular pressure** |
| **ITC** | **Iridotrabecular Contact** |
| **LASIK** | **laser Assisted In Situ Keratomileusis** |
| **LED** | **light Emitting Diode** |
| **N** | **Nasal** |
| **OCT** | **Optical coherence tomography** |
| **ONH** | **Optic Nerve Head** |
| **PAS** | **peripheral anterior synechia** |
| **PKP** | **Penetrating keratoplasty** |
| **POAG** | **Primary Open Angle Glaucoma** |
| **RADAR** | **Radio Detection And Ranging** |
| **RSOD** | **Rapid Scanning Optical Delay** |
| **S** | **Superior** |
| **SD** | **Spectral Domain** |
| **SLD** | **Super Luminescent Diode** |
| **T** | **Temporal** |
| **TD** | **Time Domain** |
| **TIA** | **Trabecular Iris Angle** |
| **TICL** | **Trabecular Iris Contact Length** |
| **TISA** | **Trabecular Iris Space Area** |
| **UBM** | **Ultrasound biomicroscopy** |

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# ABSTRACT

***Background:*** penetrating keratoplasty (PKP) is performed for a wide spectrum of corneal disorders. Glaucoma due to pupillary block or synechial angle closure or aqueous misdirection is a major complication after keratoplasty. Peripheral anterior synechia (PAS) is recognized as one of the risk factors for graft rejection and may occasionally cause intraocular pressure (IOP) elevation, it is important to evaluate anterior chamber (AC) angle in eyes after PKP

***Aim of the Work:*** to document OCT changes in the anterior chamber angle after PKP for different pathologies.

***Patients and Methods:*** this prospective non-randomized study included 10 eyes of 10 patients undergoing penetrating keratoplasty (PKP) for a variety of indications. The patients age ranged from 20 to 60 years.

***Results:*** the mean postoperative IOP was higher (15.4 ± 4.03 mmHg) than preoperative IOP (12.5 ± 2.46 mmHg), but this difference was not statistically significant [P value = 0.088]. The postoperative mean Temporal TISA was lower (0.24 ± 0.08 mm2) than preoperative Temporal TISA (0.3 ± 0.1 mm2). This difference was statistically significant [P value = 0.015]. The postoperative mean Nasal TISA was lower (0.26 ± 0.1 mm2) than preoperative Nasal TISA (0.34 ± 0.15 mm2). This difference was statistically significant [P value = 0.010]. The postoperative mean IOP in infectious keratitis was higher (16.14 ± 4.63 mmHg) than postoperative mean IOP in keratoconus (13.67 ± 1.53 mmHg), but this difference was not statistically significant [P value = 0.565].

***Conclusion:*** there is an increase in IOP post PKP but the difference was not statistically significant. There is narrowing in angle post PKP. The difference was statistically significant in temporal and nasal angles but not statistically significant in superior and inferior angles. The mean IOP was higher in infectious keratitis than keratoconus but the difference was not statistically significant. There is no correlation between corneal diameter and the changes in IOP and angle measurements.



***Keywords:*** *Penetrating Keratoplasty - Anterior Segment OCT – Angle Changes*

Penetrating keratoplasty (PKP) is performed for a wide spectrum of corneal disorders, including corneal scarring, keratoconus, aphakic and pseudophakic bullous keratopathy, Fuchs' endothelial dystrophy, and other corneal dystrophies **(Ramsay *et al,* 1997)**. It has the highest rate of success amongst all organ transplants being avascular and immuno-privileged tissue **(Brandt *et al,* 2005).**

PKP is still associated with significant complications including graft rejection, graft dehiscence. Glaucoma due to pupillary block or synechial angle closure or aqueous misdirection is a major complication after keratoplasty **(Harris *et al,* 1988)**. Sustained intraocular pressure (IOP) elevation may result in endothelial cell decompensation with corneal graft failure and loss of vision **(Wagoner *et al,* 2009).**

Potential mechanisms for such pressure elevation include retained viscoelastic material, hemorrhage, malignant glaucoma, uveitis, pupillary block, secondary angle closure glaucoma, trabecular meshwork collapse, steroid-induced effects, and preexisting glaucoma **(O'Day DG, 1997).**

Because peripheral anterior synechia (PAS) is recognized as one of the risk factors for graft rejection and may occasionally cause intraocular pressure (IOP) elevation, it is important to evaluate anterior chamber (AC) angle in eyes after PKP **(Memarzadeh *et al,* 2007).**

Optical coherence tomography (OCT) is a high-resolution cross-sectional imaging modality initially developed for retinal imaging. Anterior segment OCT (ASOCT) imaging was first described in 1994 by Izatt *et al*, using the same wavelength of light as retinal OCT, namely 830 nm **(Izatt et al, 1994).**

This wavelength is suboptimal for imaging the angle due to limited penetration through scattering tissue such as the sclera. OCT imaging of the anterior segment with a longer wavelength of 1310 nm was developed later on and had the advantages of better penetration through sclera as well as real-time imaging at 8 frames per second **(Radhakrishnan *et al*, 2001).**

In 2010, *Karadag et al*, reported that intraocular pressure increases in the early postoperative period occurred in 5.5% of eyes and chronically elevated intraocular pressure was found in 16.6% of eyes.

The incidence of raised IOP was 2% in non-inflammatory group (GROUP 1) e.g keratoconus, corneal dystrophy, and corneal ectasia compared with 7.9% incidence in inflammatory group (GROUP 2) e.g corneal abscess, traumatic scar and herpetic keratitis in early postoperative period. In late postoperative period, the incidence was 4.6% in non-inflammatory group compared with 24.8% in inflammatory group **(Karadag et al, 2010).**

| | | Group 1 | | Group 2 | | |
|---|---|---|---|---|---|---|
| Preoperative IOP | ≤21 | 306 | 100.0% | 435 | 98.2% | $\chi^2$: 5.58 |
| | >21 | 0 | 0.00% | 8 | 1.8% | $P$ = 0.018 |
| Early IOP | ≤21 | 300 | 98.0% | 408 | 92.1% | $\chi^2$: 12.3 |
| | >21 | 6 | 2.0% | 35 | 7.9% | $P$ = 0.0001 |
| Late IOP | ≤21 | 292 | 95.4% | 333 | 75.2% | $\chi^2$: 53.7 |
| | >21 | 14 | 4.6% | 110 | 24.8% | $P$ = 0.0001 |

IOP, intraocular pressure.

***Table 1.1:*** *Showing the prevalence of IOP in group 1 (non-inflammatory) compared with group 2 (inflammatory)* ***(Karadag et al, 2010).***

In 2012, Fukuda et al, examine Iridotrabecular Contact (ITC) as a peripheral anterior synechia (PAS) of patients who underwent PKP. ITC was observed in 46.7% of eyes**.** The prevalence of ITC was the highest in eyes having bullous keratopathy, whereas the ITC area and ITC index were the largest in eyes having bullous keratopathy or infectious keratitis preoperatively. No ITC was found in eyes with keratoconus **(Fukuda et al, 2012) (Figure 1.1).**

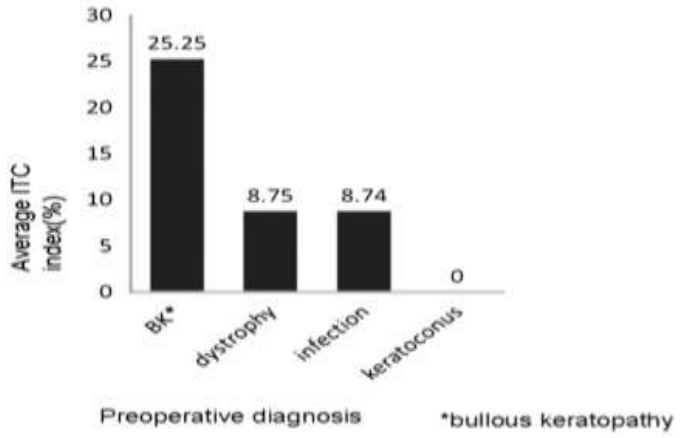


***Figure 1.1:*** *showing prevalence of average ITC area ($mm^2$) found in various operation indications for PKP. Bullous keratopathy and infection show greater average ITC area among the others* ***(Fukuda et al, 2012).***

Fukuda et al, found that prevalence and area of ITC were greater in pseudophakic or aphakic eyes compared with phakic eyes. large graft size was associated with a higher amount of ITC. Combined surgeries were also associated with great amounts of ITC compared with PKP operation alone **(Fukuda et al, 2012).**

| | Prevalence of ITC, n (%) | Average ITC Index, % | Average ITC Area, $mm^2$ |
|---|---|---|---|
| Phakia | 3/14 (21.4) | 7.9 | 2.1 |
| Pseudophakia/aphakia | 18/27 (66.7) | 21.7 | 7.5 |
| *P* | 0.009* | 0.014† | 0.012† |
| PKP+ECCE | 10/13 (76.9) | 29.0 | 11.3 |
| PKP | 11/28 (39.2) | 10.7 | 2.75 |
| *P* | 0.043* | 0.021† | 0.022† |
| PKP once | 11/30 (36.7) | 12.3 | 3.9 |
| PKP twice or more | 10/11 (90.9) | 27.8 | 9.7 |
| *P* | 0.004* | 0.009† | 0.002† |
| Graft size <7.75 mm | 4/13 (30.8) | 16.5 | 7.6 |
| Graftsize ≥7.75 mm | 16/22 (72.7) | 20.1 | 5.8 |
| *P* | 0.032* | 0.041† | 0.040† |

*$\chi^2$ test.
†Mann-Whitney *U* test.
ECCE, extracapsular cataract extraction.

***Table 1.2**: showing the association of ITC, ITC index, ITC area with each parameter **(Fukuda et al, 2012).***