Changes in Central Corneal Thickness, Corrected Intraocular Pressure, and Iridocorneal Angle in Unilateral Acute Anterior Uveitis

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ABSTRACT

Introduction: The release of inflammatory mediators in the anterior chamber can lead to the structural alteration of the corneal and uveal tissue.

Objectives: To compare the changes in Central Corneal Thickness (CCT), corrected Intraocular Pressure (cIOP) and Iridocorneal Angle (ICA) in unilateral acute anterior uveitis (AAU) before and after treatment.

Materials and methods: The study was a hospital based comparative study conducted between July 2018 to June 2019. Newly diagnosed, untreated unilateral Acute Anterior Uveitis (AAU) adult cases above 16 years were included in the study. Ethical clearance was obtained from the Institutional Review Committee of Institute of Medicine. Eighty-two unilateral AAU cases (Total 164 eyes including 82 unaffected were analyzed) underwent Goldmann applanation tonometry (GAT) and corneal topography at presentation and three weeks after treatment. The cIOP was calculated by the Ehlers formula.

Results: The mean CCT of affected eyes was greater (563.84±51.49µm) compared to unaffected eyes (535.99±31.48µm) before treatment (p=0.001) and was reduced (533.2±25.71µm) after treatment (p=0.01). There was no significant difference in IOP, cIOP, and ICA between the affected eyes (14.45±6.89mmHg, 13.14±7.14mmHg and 48.78±7.94°) and the unaffected eyes (14.02±2.36mmHg, 14.4±3.09mmHg, and 49.80°±8.21°) before treatment. There was no difference in IOP (14.04±2.76mmHg) and ICA (49.21°±6.72°) after treatment, however, there was a significant increase (p=0.01) in the cIOP (14.95±2.93mmHg).

Conclusion: In the study, CCT of affected eyes was greater compared to unaffected eyes and reduced after treatment. There was no difference in cIOP and ICA in case eyes compared to control before treatment. However, cIOP increased after treatment.

Keywords: Acute Anterior uveitis, central corneal thickness, iridocorneal angle, intraocular pressure, corrected intraocular pressure.

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INTRODUCTION

Anterior uveitis is primarily the inflammation of the anterior part of the uvea viz. iris and ciliary body. The effect of inflammation in the anterior chamber can also bring changes in anatomy and physiology of surrounding structures (Agrawal et al, 2010). Corneal endothelial changes have been demonstrated in previous studies with varying degrees of inflammation through specular microscopy (Oliveira et al., 2009; Pillai et al., 2000). The thickness of cornea is dependent on the function of endothelial pump. Thus loss of endothelial function can lead to increased corneal thickness. Some authors suggest that corneal thickness may be used as an indicator for endothelial function (Huang et al., 2015; Ozdamar et al, 2010). Moreover, previous studies have shown increase in central corneal thickness (CCT) in acute anterior uveitis and decrease in CCT after treatment (Banaee et al, 2016; Agra et al, 2014).

Intraocular pressure (IOP) is raised in some cases of uveitis which may be either due to the obstruction in aqueous outflow by exudates or swollen trabecular meshwork or secondary to the treatment with the steroids (Din et al, 2012). On the other hand, IOP can decrease as a result of ciliary body inflammation leading to decrease in aqueous production in acute anterior uveitis. It may be due to this dual effect that previous studies have not shown statistically significant increase or decrease in IOP in cases of anterior uveitis (Agra et al, 2014). The other factor that could affect the IOP measurement is the corneal thickness which has a directly proportional relationship (Orssengo and Pye, 1999;Ehlers et al, 1975). Thus, it is wise to calculate the corrected IOP (cIOP) taking in consideration of the change in corneal thickness which is possible by using the inbuilt Ehlers formula in the bon Sirius corneal topographer (Ehlers et al, 1975).

The literature in iridocorneal angle (ICA) in anterior uveitis is sparse recommending further research. One study had shown no statistically significant change in ICA after treatment of acute anterior uveitis (AAU) (Group, 2005).

This study aimed to measure and to compare the changes in CCT, cIOP, and ICA due to AAU and also the effect of the treatment in same individuals and compare it with unaffected healthy eyes.

MATERIALS AND METHODS

The study was a hospital based comparative study conducted between July 2018 to June 2019 at the uveitis clinic of B.P Koirala Lions Centre for Ophthalmic Studies, Institute of Medicine. Newly diagnosed, untreated unilateral AAU adult cases above 16 years visiting the uveitis clinic during the given period were included in the study. Patients with bilateral acute anterior uveitis, glaucoma, ocular hypertension, angle closure suspects, corneal pathologies and history of eye surgery or trauma were excluded.

Detailed history was taken from patients. Examination was done with the Haag-Streit 900 Slit lamp biomicroscope. Intraocular pressure was measured with Goldmann applanation tonometer (GAT) mounted on the slit lamp biomicroscope. Grading of cells and flare in anterior chamber was done according to Standardization of Uveitis Nomenclature (SUN) working group classification (Group, 2005).

Patients underwent corneal topography with bon Sirius corneal topographer and tomographer (CSO, Italy) which combines placido disk topography with Scheimpflug tomography of the anterior segment (Jin et al., 2021). The CCT was recorded, the ICA was measured in all the quadrants and the average in both eyes was recorded. The IOP obtained from GAT was entered in the inbuilt software of bon Sirius corneal topographer and tomographer to obtain the corrected IOP value using the Ehlers formula (Ehlers et al., 1975). The 'glaucoma summary' tab in the software of the corneal topographer was used to document all the measurements.

To avoid variations, the same experienced technician performed the corneal topography in all the patients during daytime (9am-4pm). The treatment for AAU was started with topical steroids and cycloplegic in all the patients. Specific therapies for various etiologies were started when needed. Consultation with other departments was obtained to manage the systemic diseases. Patients underwent examination after resolution of most of the intraocular inflammation evident by significant decrease in the cells and flare at three weeks of treatment (resolved or resolving stage) where a repeat CCT, IOP, cIOP, and ICA were recorded.

Data were analyzed with SPSS version 23 (SPSS Inc. Chicago, IL, USA). Entry and cleaning of the data was done by two separate people to eliminate biasness. Unpaired samples t-test was used to compare the measurements of affected eyes to that of unaffected eyes before treatment and paired samples t-test was used to compare the measurements of affected eyes before treatment versus after treatment. The p-value <0.05 was considered statistically significant.

Written informed consent was taken from the patients before enrolling in the study. Proforma designed for this study was used to record the relevant history and clinical findings. Ethical clearance was obtained from the Institutional Review Committee of Institute of Medicine (Ref. no. 284/6-11-E 074/075). Adherence with the declarations of tenets of Helsinki was maintained.

RESULTS

A total of 164 eyes of 82 unilateral acute anterior uveitis patients meeting the inclusion criteria were included in the study. Thus, 82 uveitic eyes were 'affected eyes' and 82 fellow healthy eyes served as 'unaffected eyes'.

The mean age group of the patients was 38.5±13.9 years. The minimum age was 16 years and maximum age was 77 years. Majority (30.5%, n=25) belonged to the age group of 31-40 years, followed by the age group 21-30 years (26.8%, n=22). Out of total 82 patients, 42 (51.2%) were males and 40 (48.8%) were females. Right eye was affected in 49 (59.8%) patients and left eye in 33 (40.2%) patients.

Among 82 cases of unilateral AAU, the diagnosis could be established in the 48 cases (58.5%). HLA-B27 associated AAU was the most common (15, 18.3%) underlying cause detected (Table 1).

The mean CCT, IOP, mean cIOP, and ICA were evaluated and documented in on bon Sirius Machine (Table 2).

Table 1: Etiology of acute anterior uveitis cases.

Etiology	Frequency	Percent
Idiopathic	34	41.5
HLA B27 +ve arthritis	15	18.3
Herpetic uveitis	12	14.6
Tuberculosis	6	7.4
Rheumatoid arthritis	5	6.2
Juvenile idiopathic arthritis (JIA)	2	2.4
Fuch's heterochromic iridocyclitis	2	2.4
Sarcoidosis	2	2.4
Posner Schlossman syndrome	1	1.2
Behcet's disease	1	1.2
Reiter's syndrome	1	1.2
Gout	1	1.2
Total	82	100

Table 2: Ocular parameters in unilateral acute anterior uveitis cases before and after treatment.

	Mean	Range	Standard deviation
CCT (µm)			
Affected eyes	563.84	450-725	51.49
Unaffected eyes	535.99	456-608	31.48
After treatment	533.23	442-589	25.71
IOP with GAT (mmHg)			
Affected eyes	14.45	8- 50	6.89
Unaffected eyes	14.02	10- 20	2.36
After treatment	14.04	10- 28	2.769
cIOP (mmHg)			
Affected eyes	13.14	5.22- 46.12	7.14
Unaffected eyes	14.41	6.03- 24.35	3.09
After treatment	14.95	8.91- 28	2.93
ICA (degrees)			
Affected eyes	48.78	32- 67	7.935
Unaffected eyes	49.80	31- 71	8.217
After treatment	49.21	32- 68	6.723

Table 3: Comparison of ocular parameters between Case eyes vs. Control eyes before treatment.

	Case	Control	Mean difference	p value
CCT (µm)	563.84 ± 51.49	535.99 ± 31.48	27.85	0.001
IOP (mmHg)	14.45 ± 6.89	14.02 ± 2.36	0.42	0.55
cIOP (mmHg)	14.45 ± 6.89	14.4 ± 3.09	-1.27	0.011
ICA (degrees)	48.78 ± 7.93	49.80± 8.21	-1.02	0.56

Table 4: Comparison of ocular parameters between Case eyes before and after treatment.

	Pretreatment	Post-treatment	Mean difference	p value
CCT (µm)	563.84 ± 51.49	533.23 ± 25.71	30.61	0.01
IOP (mmHg)	14.45 ± 6.89	14.04 ± 2.76	0.41	0.55
cIOP (mmHg)	14.45 ± 6.89	14.95 ± 2.93	-1.81	0.01
ICA (degrees)	48.78 ± 7.93	49.21°± 6.72	-0.42	0.55

Similarly, the comparison of these ocular parameters among the affected eyes versus unaffected eyes before treatment and after treatment have been documented below (Table 3 and Table 4).

DISCUSSION

In acute anterior uveitis, as a result of the inflammatory process in the anterior chamber, the cornea and the iridocorneal angle are also affected (Agrawal et al, 2010). It is not only defined by the cellular activities but also by the changes in the corneal parameters and iridocorneal angles. Endothelial anomalies leading to its dysfunction have been well-established in cases of anterior uveitis (Oliveira et al, 2009; Pillai et al, 2000). The endothelial dysfunction leads to changes in the thickness of the cornea (Ozdamar et al, 2010). In this study, measurement of central corneal thickness, iridocorneal angle, and corrected intraocular pressure was done with bon Sirius corneal topographer which is less operator dependent than the traditional corneal pachymetry (Jin et al, 2021).

In the study, the mean CCT of case eyes was 563.84 ± 51.49µm and mean CCT of control eyes was 535.99 ± 31.48µm before the initiation of treatment. Thus, the mean CCT of case eyes was significantly higher than the control eyes before treatment (p=0.001). The mean CCT of case eyes after three-week treatment reduced to 533.23 ± 25.708µm. This decrease in CCT after 3 weeks treatment of the AAU was statistically significant (p=0.001). This matches with the study done by Banaee et al (2016) where the mean CCT was found to be significantly greater in affected eyes (514.0 ± 23.0 µm) than in unaffected fellow eyes (493.2 ± 10.6 µm) and significant change in CCT after treatment of affected eyes for just one week was reported . Similarly, Agra et al (2014) reported significant decrease of corneal thickness 15 days after treatment of AAU . Thus, this proves central

corneal thickness increases during active acute anterior uveitis.

The increased corneal thickness in AAU could be due to the endothelial dysfunction caused by the inflammation in the anterior chamber. Since endothelium is responsible for maintaining the relative dehydrated state of cornea, the failure of active pumps in endothelium leads to hydration of cornea and thus the increased central corneal thickness and with treatment the change is reversed (Oliveira et al, 2009; Pillai et al, 2000). Hence, the change in the corneal thickness can be considered an important diagnostic factor about the status of the anterior chamber inflammation. In our study, the IOP using GAT of case eyes was 14.45 ± 6.89 mmHg and the IOP ranged from 8-50mmHg. The hypertensive uveitis was found in herpetic uveitis cases (14.6%) and Posner Schlossman Syndrome (1.2%) which was managed with the adjuvant anti-glaucoma agents. There were few cases (18.3%) of hypotension uveitis present in HLA B 27 positive cases. But the mean IOP of the control eyes was 14.02 ± 2.36 mmHg before treatment thus there was no significant difference between the mean IOP of case and control eyes (p=0.597). The mean IOP of case eyes after treatment was 14.04 ± 2.76 mmHg which was also not significantly changed after the treatment. This finding is consistent with the study by Agra et al (2014) where there was no change in intraocular pressure after treatment of acute anterior uveitis .

One of the main objectives of our study was to correlate acute anterior uveitis with the corrected intraocular pressure (cIOP). The IOP obtained from GAT was further corrected for changes with central corneal thickness by the widely used Ehlers formula inbuilt in the topographer. Ehlers et al (1975) stated that GAT yields accurate IOP measurement only at a central corneal thickness of about 520 μm which is considered average "normal" CCT in general population . Applanation reading is low when thickness is below normal and high when thickness is above normal. The average error caused by thicker or thinner cornea as calculated by Ehlers et al (1975) was 0.7 mmHg per 10 μm deviation from "normal" .

The mean cIOP of the case eyes was 13.14 ± 7.14 mmHg and control eyes had mean cIOP of 14.4 mmHg before treatment. Though the mean cIOP was slightly lower in the case eyes there was no statistically significant difference (p=0.14). However, the mean cIOP after treatment (14.95 ± 2.93 mmHg) was slightly higher than before treatment and was statistically significant (p=0.01). The results could mean that simply taking IOP without correcting for the change in CCT would not be beneficial in management of the intraocular pressure in AAU. Glaucoma, a frequent complication of uveitis, has been described in 20% of the cases of uveitis (Bodh et al, 2011). Anterior uveitis can cause elevation of IOP in some cases (Din et al, 2012) while in others IOP may be unchanged or even depressed (Agrawal et al, 2010). This may be the reason why the net result appears as non significant effect in the pooled data as ours. Concurrent use of steroids also increases intraocular pressure (Phulke et al, 2017). Thus, the management of intraocular pressure in acute anterior uveitis should be individualized. More study is needed to correlate the effects of anterior uveitis with corrected IOP.

Before treatment, the mean ICA of case eyes

(48.78 ± 7.93°) was almost the same as the mean ICA of control eyes (49.80°± 8.21°) (P=0.418). The mean ICA of case eyes after treatment (49.21°±6.72°) had no significant difference when compared to the pretreatment measurements. The inflammation of iris leads to its swelling which could cause decrease in ICA. Moreover, formation of posterior synechiae with seclusio or occlusio pupillae may push the iris forward due and peripheral anterior synechiae may also lead to shallowing of the angle (Bodh et al, 2011). Though the mean ICA was slightly less in case eyes than the control eyes in our study, the difference was statistically nonsignificant.

The strength of this study is that it is the first ever prospective report among the Nepalese uveitis patients where the measurements were done in the eyes of same individual viz. affected eye served as the case and unaffected eye served as the control. This eliminates most of the biases between cases and controls. We corrected the intraocular pressure for change in central corneal thickness. Moreover, we used the modern corneal topographer which makes it less operator dependent than the traditional pachymetry. Small sample size, short-term follow-up, lack of etiological classification of the uveitic cases are the limitations of our study among the affected eye. Similarly, inability to use laser cell flare meter for the identification of the subclinical cellular activity in the contralateral eye were the limitations of this study. We also recommend for a longer study period with a large population in future.

CONCLUSION

We found that in acute anterior uveitis there was significant increase in the central corneal thickness but there was no significant change in intraocular pressure, corrected intraocular pressure and iridocorneal angle. The resolution of anterior chamber reaction with the treatment of acute anterior uveitis led to decrease in central corneal thickness. Central corneal thickness could be a valuable tool in anterior uveitis. Judicious use of corrected intraocular pressure measurement to manage altered intraocular pressure in cases with deviation of central corneal thickness should be done to prevent further ocular morbidities.

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