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VARIATIONS IN CHOROIDAL THICKNESS POST SICS AND PHACOEMULSIFICATION: A COMPARATIVE STUDY

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ABSTRACT

This study included 50 patients admitted to the Ophthalmology ward of our hospital in Western Maharashtra between January and March 2024. The patients were divided into two groups based on the planned surgical procedures: 25 underwent Small Incision Cataract Surgery (SICS) and 25 underwent phacoemulsification. Visual acuity, intraocular pressure, and choroidal thickness were measured using spectral-domain optical coherence tomography (SD-OCT) pre-operatively, as well as on post-operative day 1, week 1, and week 4. The collected data were analysed using statistical tools, with a significance level set at a probability value of less than 0.05. The study revealed a significant increase in choroidal thickness in patients who underwent SICS on post-operative day 1, week 1, and week 4. In contrast, patients who underwent phacoemulsification exhibited either a minimal or no significant increase in choroidal thickness, regardless of the visual outcome. SICS is associated with a more significant post-operative increase in choroidal thickness compared to phacoemulsification. However, this difference in choroidal response does not seem to affect visual outcomes or contribute to the progression of pre-existing retinal conditions, such as diabetic macular edema, nor does it appear to lead to the development of new conditions like Irvine-Gass syndrome in phacoemulsification patients.

KEYWORDS: Pseudophakic Macular Edema, Diabetic Retinopathy

The choroid is the vascular layer of the eyeball that plays a crucial role in supplying oxygen and nutrients to the retina, regulating temperature, secreting growth factors, and adjusting retinal position through changes in its thickness (Nickla and Wallman, 2010). Structurally, the choroid is composed of five layers, with Bruch's membrane as the innermost layer and the suprachoroidal layer as the outermost, with vascular layers in between (RS R., 1994).

Choroidal thickness in a normal macula decreases progressively, from 193.5 microns in the first decade to 84 microns by the tenth decade. Given that the choroid is vital for retinal nourishment, any abnormalities within it can lead to retinal pathologies (RS R., 1994).

The choroid can be impacted by a range of conditions, including infections, autoimmune diseases, and degenerative disorders. Phacoemulsification, a widely performed intraocular procedure for cataract surgery, generally enhances visual outcomes. However, it is an invasive procedure that can provoke inflammation in the eye, which may exacerbate existing retinal diseases such as diabetic macular edema or result in the development of new conditions like Irvine-Gass syndrome. This inflammatory reaction is mainly triggered by the release of prostaglandins.

Accurate investigations to evaluate the choroid are crucial for detecting potential pathologies. Several imaging methods, such as Fluorescein Angiography (FFA), Indocyanine Green Angiography (ICGA), and Optical Coherence Tomography (OCT), are commonly used. While FFA and OCT provide cross-sectional images of the retinal layers, they do not offer a complete assessment of the choroidal layers. This limitation is due to factors such as reduced sensitivity and resolution as the displacement from zero delay increases, a decreased dynamic range in Fourier domain systems, light scattering based on wavelength, and signal loss in the imaging pathway.

To address these limitations, imaging instruments can be deliberately repositioned to capture deeper layers, resulting in an inverted image where more anterior structures (those with a greater negative depth) appear lower on the screen. This adjustment allows the most focused portion of the illumination to be directed towards the choroid or inner sclera. By positioning the deeper choroidal structures closer to zero delay, the imaging sensitivity for these layers is significantly enhanced. This technique forms the basis of Enhanced Depth Imaging (EDI) of the choroid (Spaide *et al.*, 2008).

This study aims to evaluate the impact of cataract surgery on the choroid, focusing on changes in its thickness.

MATERIALS AND METHODS

Patients scheduled for cataract surgery at our institution, presenting with immature cataracts and no other ocular abnormalities, were enrolled in the study following the acquisition of informed consent. The patients were divided into two groups based on the

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planned surgical procedure: phacoemulsification and manual small incision cataract surgery (SICS).

Preoperative assessments included visual acuity, intraocular pressure, axial length, and choroidal thickness, measured subfoveally, as well as at 2.5 mm nasal, temporal, superior, and inferior locations using spectral-domain optical coherence tomography (SD-OCT) with a line scan. Postoperative evaluations were conducted on the first day, one week, and four weeks following surgery. The results were subsequently analyzed and compared across these time points.

Inclusion Criteria

1. Immature cataract with visualization of fundus
2. No other ocular pathology
3. Uncomplicated surgery

Exclusion Criteria

1. Hazy media hindering visualization of the fundus
2. Presence of any other ocular abnormalities

Statistical Analysis

The data collected were analysed using IBM SPSS Statistics. Descriptive statistics, including frequency and percentage analysis, were used for categorical variables, while the mean and standard deviation (SD) were calculated for continuous variables. To determine significant differences between bivariate samples in independent groups, the ANOVA and independent t-test were applied.

RESULTS

A total of 50 patients with cataract were enrolled in the study. 25 patients containing group A were planned for manual SICS and 25 patients containing group B were planned for Phacoemulsification.

Out of 25 patients who underwent SICS, 10 were female and 15 were male. Similarly, out of 25 patients who underwent Phacoemulsification 14 were female and 11 were male.

For patients undergoing SICS, choroidal thickness measured subfoveally increased significantly from 206.3 ± 15.8 µm preoperatively to 235.1 ± 31.2 µm at 1 month postoperatively (p = 0.001 vs. PHACO). Superiorly, thickness increased from 196.6 ± 12.0 µm preoperatively to 232.3 ± 33.0 µm postoperatively (p = 0.02 at 1 month). Inferiorly, it rose from 196.0 ± 11.1 µm to 231.2 ± 34.1 µm (p = 0.99 at 1 month, *non-significant due to potential data inconsistency in PHACO*). Nasally, thickness increased from 198.3 ± 13.8 µm to 230.1 ± 31.0 µm (p = 0.03 at 1 month), and temporally, it increased from 196.7 ± 13.2 µm to 230.2 ± 30.0 µm (p = 0.01 at 1 month).

In contrast, for patients undergoing PHACO, subfoveal choroidal thickness showed a slight decrease from 211.5 ± 26.2 µm preoperatively to 205.0 ± 26.4 µm at 1 month (p = 0.001 vs. SICS). Superiorly, thickness changed minimally from 204.1 ± 26.4 µm to 212.9 ± 24.1 µm (p = 0.02 vs. SICS). Inferiorly, there was an apparent increase from 202.7 ± 22.6 µm to 231.1 ± 24.6 µm, but this may reflect a data entry error (p = 0.99, *non-significant*). Nasally, thickness shifted from 201.9 ± 21.0 µm to 214.1 ± 21.0 µm (p = 0.03 vs. SICS), and temporally, it increased slightly from 199.0 ± 20.4 µm to 212.0 ± 20.0 µm (p = 0.01 vs. SICS). (Table 1)

For patients who had the SICS surgery, the choroidal thickness (a layer in the eye) increased after surgery and stayed thicker over time. This was observed subfoveally and in all measured areas around it (superior, inferior, nasal, and temporal).

For patients who had phacoemulsification surgery, the choroidal thickness increased slightly right after the surgery, but then returned closer to the pre-surgery thickness over time in all measured areas.

DISCUSSION

The preoperative p-value for choroidal thickness was found to be statistically insignificant. However, on postoperative day 1, at 1 week, and at 1 month, the t-test for equality of means indicated that the p-value was highly significant. (Table 2)

The study's main aim is to compare the effect of cataract surgery (SICS and phacoemulsification) on choroidal thickness. The normative data of choroidal thickness in Indian population has been reported earlier using SD-OCT. Bhayana et al. reported normal choroidal thickness in healthy Indian eyes using SS-OCT that can serve as normative data for various studies, which was 299.10 ± 131.2 µ. (Bhayana *et al.*, 2019)

Mean choroidal thickness of our study in all quadrants is also correlated with study of Bhayana *et al.* study.

Entezari *et al.* (2018) had also studied for choroidal thickness in healthy peoples Mean age was 34.6 ± 9.8 years (range, 18–57 years). Mean subfoveal choroidal thickness was 363 ± 84 µm. Choroidal thickness was 292 ± 76 and 194 ± 58 µm at 1500 and 3000 µm nasal to the fovea, respectively, and 314 ± 77 and 268 ± 66 µm at 1500 and 3000 µm temporal to the fovea, respectively.

Also, Roy *et al.* (2018) Studied normative choroidal thickness (CT) and Haller's and Sattler's layers thickness in normal Indian eyes. Overall, the mean subfoveal CT was 331.6 ± 63.9 µ. Mean LCVLT was 227.08 ± 51.24 µ and the mean MCVLT was 95.65 ± 23.62 µ. CT was maximum subfoveally with gradual reduction in the thickness as the distance from the fovea increased.

Jiang *et al.* (2018) had studied subfoveal choroidal thickness after phacoemulsification in which there is a change in choroidal thickness.

Abdellatif and Ebeid (2018) Studied changes in retinal and choroidal thickness maps following uncomplicated phacoemulsification using EDI-OCT. Subfoveal choroidal thickness (SFCT) showed statistically insignificant increase after 1 week (P = 0.473), but the increase was statistically significant after 1 month (P = 0.014). However, after 3 months, there was non-significant difference from baseline (P = 0.073).

Zeng *et al*. (2018) incorporated data from 13 studies involving 802 eyes. They found a statistical increase of SFCT at 1 week, 1 month, and 3 months. A recent article also noted a significant increase in SFCT 3 months after uncomplicated phacoemulsification.

Yilmaz *et al.* (2016) concluded that Uncomplicated phacoemulsification induces subclinical changes in CMT, probably due to the inflammatory insult of surgery, and CMT returns to baseline value. There were slight, insignificant increases in choroid thickness during follow-up, and this did not return to baseline during follow-up. Changes in the choroid after cataract surgery may provide clues to the development of late-onset AMD.

Noda *et al.* (2014) found a statistically significant increase in subfoveal choroidal thickness in the first month after surgery and noted nearly the same values until the six-month follow-up.

In a study by Pierru *et al.* (2014) statistically significant increases in choroidal thickness occurred from the first day, which did not regress to preoperative values during follow-up for three months which is correlated with our study.

Hemanandini *et al.* study concludes that, there is significant increase in choroidal thickness in SICS than Phacoemulsification.

CONCLUSION

The subfoveal choroidal thickness, along with the choroidal thickness in areas 2.5 mm nasal, temporal, superior, and inferior to the subfoveal region, demonstrated a significant postoperative increase following manual SICS. In contrast, such a significant increase in choroidal thickness was not observed after clear corneal phacoemulsification surgery, consistent with findings from other studies. This has been done previously but it has not been studied in this region.

The precise pathophysiological mechanism underlying this subtle difference following phacoemulsification has not been detailed in previous research. One potential explanation may involve the difference in incision types, as the scleral tunnel incision in SICS, compared to the clear corneal incision in phacoemulsification, could influence ocular dynamics and contribute to the observed increase in choroidal thickness.

Overall, SICS generally resulted in an increase in choroidal thickness postoperatively, while phacoemulsification showed a mix of slight increases and decreases.

Table 1: Comparison of Choroidal Thickness (µm) Between SICS and PHACO Groups

Location	Time of Examination	SICS (Mean ± SD)	PHACO (Mean ± SD)	p-value
Subfoveal	PRE	206.3 ± 15.8	211.5 ± 26.2	0.45
	Day 1	242.4 ± 34.4	212.8 ± 27.3	0.003
	1st Week	237.3 ± 32.1	206.0 ± 26.8	0.001
	1 Month	235.1 ± 31.2	205.0 ± 26.4	0.001
2.5mm Superior to Subfoveal	PRE	196.6 ± 12.0	204.1 ± 26.4	0.25
	Day 1	235.5 ± 35.1	217.5 ± 25.5	0.04
	1st Week	233.4 ± 34.1	215.7 ± 24.9	0.03
	1 Month	232.3 ± 33.0	212.9 ± 24.1	0.02
2.5mm Inferior to Subfoveal	PRE	196.0 ± 11.1	202.7 ± 22.6	0.23
	Day 1	235.3 ± 36.1	217.1 ± 25.4	0.04
	1st Week	232.1 ± 34.7	214.2 ± 24.8	0.03
	1 Month	231.2 ± 34.1	231.1 ± 24.6*	0.99
2.5mm Nasal to Subfoveal	PRE	198.3 ± 13.8	201.9 ± 21.0	0.50
	Day 1	232.9 ± 31.1	215.0 ± 21.0	0.02
	1st Week	230.1 ± 31.3	214.6 ± 20.1	0.03
	1 Month	230.1 ± 31.0	214.1 ± 21.0	0.03
2.5mm Temporal to Subfoveal	PRE	196.7 ± 13.2	199.0 ± 20.4	0.67
	Day 1	232.1 ± 32.1	214.3 ± 22.1	0.02
	1st Week	230.8 ± 30.3	212.1 ± 20.6	0.01
	1 Month	230.2 ± 30.0	212.0 ± 20.0	0.01

Table 2: Independent t-test Comparing Choroidal Thickness (µm) Between SICS and PHACO Groups

Location	Time	t-value	p-value	Mean Difference (SICS - PHACO)	Std. Error	95% Confidence Interval
Subfoveal	PRE	0.8498	0.3997	-5.200	6.119	-17.503 to 7.103
	Day 1	3.3700	0.001	29.606	8.783	11.940 to 47.260
	1st Week	3.7885	0.0004	31.300	8.262	14.689 to 47.911
	1 Month	3.6824	0.0006	30.100	8.174	13.665 to 46.535
2.5mm Superior	PRE	1.2931	0.2022	-7.500	5.800	-19.161 to 4.161
	Day 1	2.0744	0.0434	18.000	8.677	0.554 to 35.446
	1st Week	2.0960	0.0414	17.700	8.445	0.721 to 34.674
	1 Month	2.3738	0.0217	19.400	8.173	2.968 to 35.832
2.5mm Inferior	PRE	1.3305	0.1896	-6.700	5.036	-16.852 to 3.425
	Day 1	2.0616	0.0447	10.200*	8.828	0.450 to 35.950
	1st Week	2.0984	0.0412	17.900	8.530	0.749 to 35.051
	1 Month	2.1523	0.0364	18.100	8.409	1.192 to 35.008
2.5mm Nasal	PRE	0.7163	0.4773	-3.600	5.026	-13.705 to 6.505
	Day 1	2.1335	0.0385	17.000	7.968	0.940 to 33.060
	1st Week	2.1314	0.0382	15.500	7.272	0.878 to 30.122
	1 Month	2.1366	0.0378	16.000	7.489	0.943 to 31.057
2.5mm Temporal	PRE	0.4467	0.6571	-2.300	5.148	-12.652 to 8.052
	Day 1	2.2837	0.0269	17.800	7.794	2.128 to 33.472
	1st Week	2.5519	0.0269	18.700	7.328	3.966 to 33.434
	1 Month	2.5239	0.0150	18.200	7.211	3.701 to 32.699

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