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Factors Impacting Cumulative Dissipated Energy in Phacoemulsification: A Tertiary Care Hospital Study

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Abstract

Background: The goal of our study is to provide surgeons with accurate indicators of the amount of ultrasound released during phacoemulsification. The impact of age, cataract grade, and diabetic state on cumulative dissipated energy was examined in the current study.

Aim: To study the correlation of cumulative dissipated energy levels with diabetic status, age of the patient, grade of cataract and postoperative endothelial cell density changes in patients undergoing phacoemulsification.

Methodology: Over the course of one and a half years, a prospective, observational, cohort study was carried out in the hospital. Patients with and without diabetes who were diagnosed with a visually significant cataract by slit lamp examination and graded using the Lens Opacity Classification System III (LOCS III) were included in the study group. The patient's cataract was extracted using phacoemulsification. Cumulative dissipated energy (CDE) was noted in every case, and its correlation with diabetic status, age of patient at the time of surgery, grade of cataract and endothelial cell density changes post phacoemulsification was studied.

Results: Over the course of one and a half years, 60 patients were included in this study. Thirty patients did not have diabetes, and thirty patients did. Age distribution of patients ranged between 50 to 70 years with a Mean age of 56.75±4.17 years. Mean duration of diabetes was 4.67±2.86 years. Mean HbA1c value of diabetic patients was 6.12 ± 0.38%. There was no statistically significant difference in cumulative dissipated energy between diabetic and non-diabetic patients, with p p-value of 0.36. There was a statistically significant positive correlation between grade of cataract, age of patients and cumulative dissipated energy with [CDE (MEAN ± SD):3.82±1.52 and grade of cataract 0.68 and CDE (MEAN ± SD):3.82±1.52 and Age of patients 0.828]. Correlation was significant at the 0.001 level (2-tailed). The cumulative dissipated energy increased with age and cataract grade. With a p-value of 0.36. There was a negative correlation between mean cumulative dissipated energy and postoperative endothelial cell density. [CDE (MEAN± SD):3.82±1.52 and Endothelial cell density -0.639]. Correlation was significant at the 0.001 level (2-tailed).

Conclusion: Higher CDE is substantially correlated with older age, higher nuclear sclerosis grade. The more cumulative dissipated energy used during phacoemulsification; more is the decrease in endothelial cell density on postoperative follow-up. One unknown but significant factor that influences iatrogenic damage, like the loss of corneal endothelial cells, which might result in long-term complications, is the degree of ultrasonic exposure during phacoemulsification

Keywords: Cumulative Dissipated Energy, Phacoemulsification, Endothelial Cell Density, Diabetes

Introduction

The use of ultrasonic (US) energy during phacoemulsification may result in tissue injury and the loss of endothelial cells. The phacoemulsification unit has a built-in system of CDE (cumulative dissipated energy) measurement. It displays the number of seconds needed to finish a phacoemulsification case, which indicates how much energy will be used. Less time spent phacoemulsifying equals less energy used in the eye, which is beneficial for the corneal endothelium. In an effort to enhance surgical results, 1-4 CDE is used as a gauge of surgical effectiveness. CDE data are not being used for this purpose very frequently. A higher CDE value is correlated with longer surgical and recuperation times because more energy is lost in the eye and causing more damage to ocular tissue. Less CDE and successful cataract phacoemulsification may lead to more effective surgery and better overall results. [1,2,3,4,5,6]. There is a correlation between the energy used during phacoemulsification, as measured by CDE (cumulative dissipated energy), and the various corneal endothelial change parameters, according to numerous studies that have shown that cataract extraction by phacoemulsification appears to be more traumatic to the corneal endothelium than the intracapsular extraction.

Preoperative BCVA (best-corrected visual acuity), diabetes, white-to-white corneal diameter, clinical nuclear sclerosis grade, cataract disassembly technique, surgeon training level, surgical centre, and patient age at the time of surgery all significantly correlate with CDE levels. Higher CDE is substantially correlated with older age, diabetes, a worse preoperative BCVA, a higher nuclear sclerosis grade, a larger white-to-white corneal diameter, and adoption of different disassembly methods [7].

Materials And Methods:

Over the course of one and a half years, from January 2021 to June 2022, the **Postgraduate Department of Ophthalmology at Government Medical College Srinagar** conducted a prospective, observational, cohort study that was hospital-based. The study was approved by the institutional ethical committee.

The study group included 60 eyes of 60 patients, diabetic and non-diabetic who were diagnosed with age-related cataract and graded by the lens opacity classification system III (LOCS III). The patients underwent phacoemulsification and intraocular lens implantation.

Inclusion criteria comprised of

(1) Patients aged between 50 and 70 years.

(2) Patients diagnosed with visually significant age-related cataract posted for phacoemulsification surgery and IOL implantation.

(3) Type 2 diabetes cases with HbA1c values less than 7.0, which is regarded as having satisfactory glycaemic control.

Exclusion criteria:

(1) History of prior eye surgery.

(2) Increase in intraocular pressure.

(3) Any corneal pathology that already exists.

(4) Grade 4 nuclear sclerosis.

(5) Ocular trauma history.

(6) Pseudo exfoliation.

(7) Endothelial count of less than 1500 cells per millimetre square before surgery.

(8) Contact lens use.

(9) Inflammation inside the eye.

(10) Complications during surgery.

(11) Systemic conditions that impact the surface of the eye, such as Fabry's disease, Wilson's disease, mucopolysaccharidoses, and collagen vascular disorders.

Following an explanation of the study's goal and methodology, the patient gave their informed consent. Age, gender, medical history, surgical history, and personal history were among the demographic and clinical data that were documented. Basic ophthalmic examinations were performed on the patients, which included dilated fundus examination, specular biomicroscopy (Topcon model-SP-IP), slit lamp examination, intraocular pressure measurement by applanation tonometry, biometry, and visual acuity assessment.

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Cataract Surgical Procedure

All the individuals were operated on by a single surgeon using a standard technique with the same phacoemulsification equipment (Centurion phaco system) at similar settings. To put it briefly, anterior capsulorhexis was carried out after a clean corneal incision was made. This was followed by hydrodissection, either with or without hydrodelineation. The single nucleotomy method, known as the stop and chop technique, was used to remove the lens nucleus. The cortex and epinucleus were removed, and an acrylic intraocular lens (IOL) was placed inside the bag. A prophylactic intracameral or subconjunctival antibiotic was given.

Outcome Measures And Analysed Factors

Cumulative dissipated energy (CDE) was noted in every case and was analysed as a continuous response variable, and all the participants were followed up at intervals of one week, one month and three months post-phacoemulsification to study and compare corneal endothelial cell density changes caused after phacoemulsification surgery in diabetic and non-diabetic patients.

Statistical Analysis:

A Microsoft Excel spreadsheet was used to compile and enter the recorded data. The mean and standard deviation were used to summarise continuous variables. Frequencies and percentages were used to summarise categorical variables. The mean and standard deviation of the change in endothelial cell density for each group were calculated. Two-way repeated measure ANOVA was used to analyse intragroup differences in both groups at all time intervals and changes from the baseline. The SNK test was used to perform post hoc analysis between the two groups. The threshold for statistical significance was set at $p<0.001$. R Studio was used for data analysis. Spearman correlation was used to correlate continuous variables with categorical variables, and Pearson correlation was used to correlate continuous variables with one another.

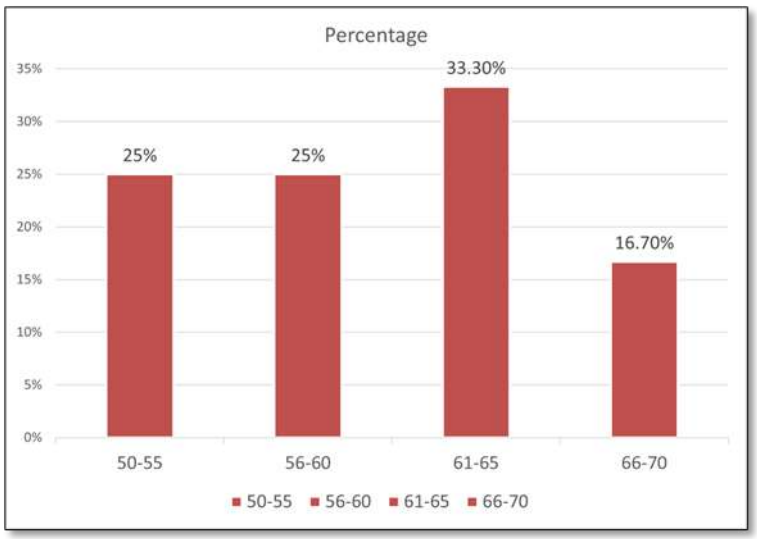
Results:

Baseline Characteristics:

Over the course of one and a half years, 60 patients were included in this study. Of the 60 patients, 30 had diabetes, and the remaining 30 did not.

Age Distribution: In this study, the ages of patients ranged between 50 to 70 years, with a Mean age of 56.75±4.17 years.

Figure 1: Age Distribution Of Study Patients



The Correlation is Significant at the 0.001 level (2-tailed).

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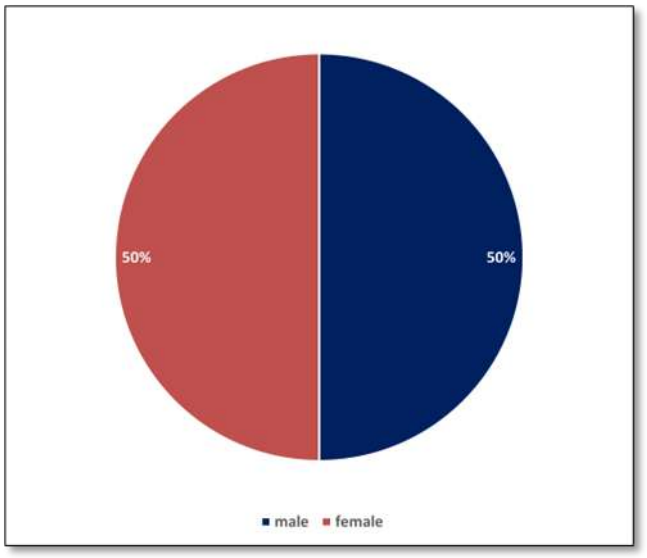
Figure 2: Gender Distribution Of Study Patients



A total of 30 males (50%) and 30 females (50%) participated in the study.

Table 1: Diabetic Profile Of Patients In Diabetic Group

Characteristic	Statistic
Mean duration of diabetes ±SD	4.67±2.86
Mean HbA1c ±SD (Range) in %	6.12±0.38(5.40-6.90)

Mean duration of diabetes was 4.67±2.86. Mean HbA1c values of diabetic patients ranged from 5.40% to 6.90%, with a mean value: 6.12 ± 0.38%.

The Cumulative Dissipated Energy (CDE) was not statistically significant between diabetic and non-diabetic, with p p-value of 0.36. There was a statistically significant correlation seen between cumulative dissipated energy and the grade of cataract. We noted the mean CDE of 3.82±1.52 and the Grade of cataract 0.68. A higher grade of cataract was associated with higher levels of cumulative dissipated energy during the procedure. A statistically significant correlation was also observed between cumulative dissipated energy and the age of the patient. We observed a mean CDE of 3.82±1.52, and the Age of patients was 0.828. The level of CDE increased with the increasing age of the patients. Correlation was significant at the 0.001 level (2-tailed). There was a negative correlation between mean cumulative dissipated energy and postoperative endothelial cell density. (CDE (MEAN± SD):3.82±1.52 and Endothelial cell density -0.639). Correlation was significant at the 0.001 level. The more the cumulative dissipated energy used during phacoemulsification, the less was the postoperative endothelial cell density on follow-up.

Table 2: Comparison Of Diabetic And Non-Diabetic Groups With Respect To CDE

Parameter	Groups		t statistic	p value
	Diabetic	Non-Diabetic		
CDE	5.34	4.84	0.90	0.36

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Table 3: Comparison Between Age And Duration Of Diabetes With CDE

Parameter	Mean	Median	Std. Deviation	Minimum	Maximum	Range
Age	56.75	57.00	4.17	50.00	64.00	14.00
CDE	3.82	4.10	1.52	1.20	6.70	5.50
Duration of Diabetes	4.67	4.00	2.86	1.00	10.00	9.00

Figure 3: Comparison Of Diabetic And Non-Diabetic Groups With Respect To CDE

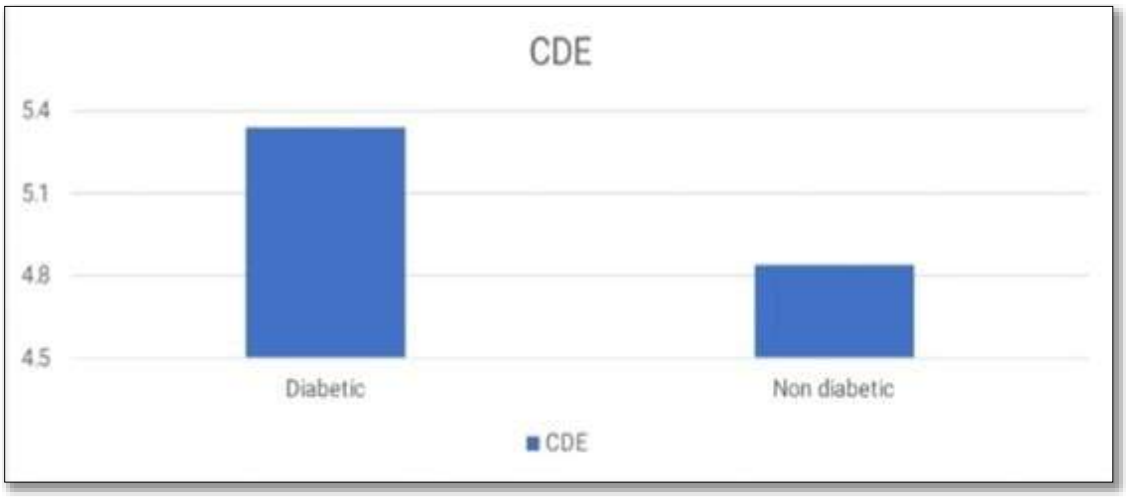

Table 4: Correlations Between CDE And Three Risk Factors

	Grade Of Cataract	Age Of Patients	Endothelial Cell Density
CDE	**0.680**	**0.828**	**-0.639**

Mean of CDE: 3.82±1.52; Correlation is Significant at p< 0.001

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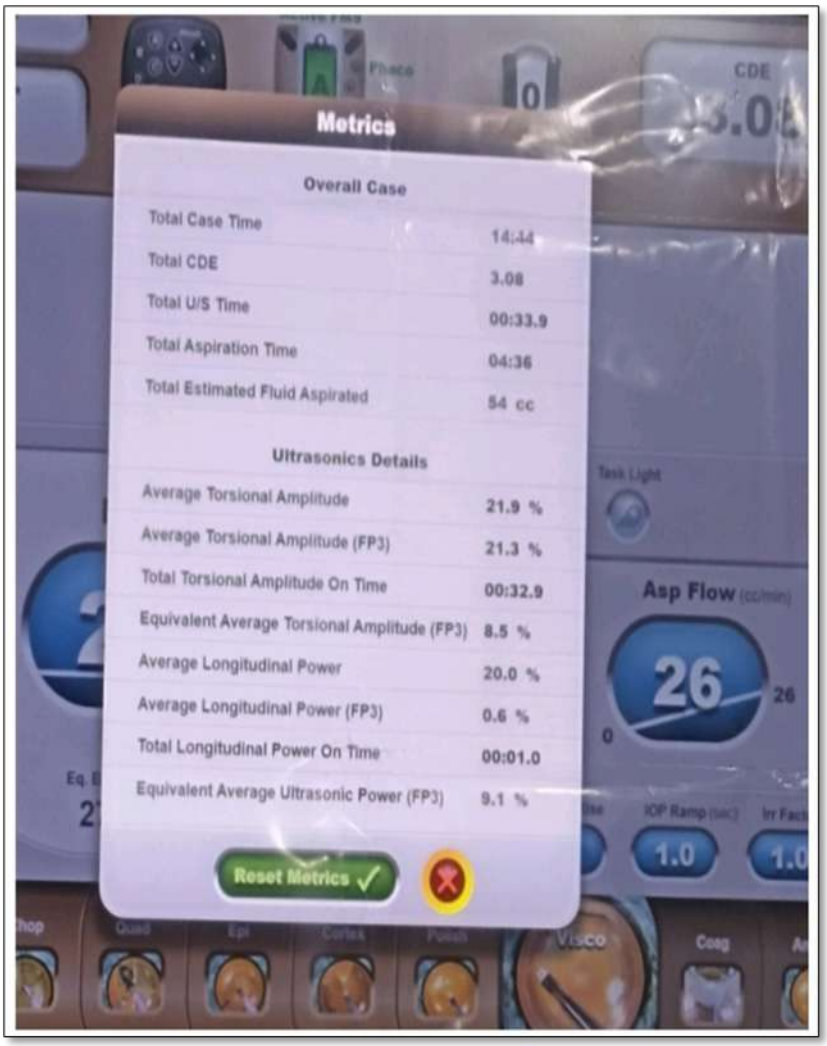
Figure 4: CDE Of Patient After Phacoemulsification



Discussion:

The impact of age, cataract grade, and diabetes state on cumulative dissipated energy was examined in the current study. Our goal is to give surgeons accurate indicators of the amounts of ultrasound released during phacoemulsification. Although there is ongoing discussion on the potential for ultrasonic exposure to cause iatrogenic damage to ocular tissue, cataract surgeons currently agree that limiting ultrasonic exposure to ocular tissue during surgery is a good idea. The extent of ultrasonic exposure during phacoemulsification is a hidden but significant driver of iatrogenic harm, such as corneal endothelial cell death, which may result in long-term consequences, in addition to direct instrumental damage to ocular tissues. In addition to causing heat dissipation in the ocular tissues, ultrasonic exposure can also generate hydroxyl radicals in the anterior chamber and cause acoustic cavitation [6,7,8]. Although it is normal for the number of endothelial cells to decrease with age, there have been reports of increased rates of endothelial cell loss following cataract surgery, ranging from around 4 to 20% within the year after the procedure (7). While some studies have found no significant correlation, others have found a positive relationship between CDE levels and the rate of endothelial cell loss [6–8, 10, 11]. More research is required to determine the long-term impact of CDE on corneal conditions. We hypothesised that whereas CDE level might not matter in ordinary situations, it might matter for patients who are more likely to experience problems, like for elderly patients or those with a history of ocular disease, predicting CDE before cataract surgery may help determine the optimal course of action to preserve corneal tissue. The

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cumulative dissipated energy of patients with and without diabetes did not differ statistically significantly. A statistically significant relationship between cumulative dissipated energy and endothelial cell density, age, and cataract grade was observed. This cumulative dissipated energy increased with age and cataract grade. The postoperative endothelial cell density decreased more in cases of increased cumulative dissipated energy during surgery.

This association is clinically important and should be considered when deciding optimal timing for cataract surgery, particularly in eyes with ocular co-morbidities. Higher CDE was substantially correlated with both age and nuclear sclerosis grade (increase in log10CDE by 0.12–0.41 for NS grade..2, $p < 0.001$). The findings of the present study are in agreement with the findings of previous works. Given that diabetic individuals in our study had good glucose control, the results of this study may be unique, which sets it apart from previous research studies.

Conclusion:

Corneal endothelial cells are susceptible to trauma caused by the phacoemulsification procedure, especially in diabetic patients. Our study's findings demonstrated that patients with diabetes mellitus have distinct corneal endothelium behaviour following cataract surgery. In order to reduce endothelial cell damage from mechanical manoeuvres or ultrasonic load, diabetic patients should have their follow-up tailored and receive special attention during surgery. Cumulative dissipated energy (CDE), which was measured and reported by the phacoemulsification system, was commonly used to quantify the amount of ultrasonic exposure during phacoemulsification. Age, endothelial cell density, cumulative dissipated energy, and cataract grade all showed statistically significant correlations. In proportion to age and cataract grade, the total energy dissipated was more. The postoperative endothelial cell density was lower in cases of more cumulative dissipated energy during surgery. The current study's results are consistent with those of earlier research. However, more research in a long-term longitudinal cohort study is required to determine whether these differences persist over time.

Acknowledgement: The authors would like to acknowledge all the patients who participated in this study.

Ethical clearance: The study was undertaken after obtaining clearance from the institutional ethical committee.

Conflict of interest: The authors declare no conflict of interest.

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