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COMPARATIVE STUDY BETWEEN PHACOEMULSIFICATION AND SMALL INCISION CATARACT SURGERY ON THE AXIAL LENGTH AND ANTERIOR CHAMBER DEPTH

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Abstract

Aim: To compare the effect of phacoemulsification and small incision cataract surgery on axial length and anterior chamber depth.

Method: An observational cohort study was conducted on 90 participants (48 females and 42 males) who were scheduled to undergo cataract surgeries at Adetula Opticals Eye Clinic, Oshodi-Isolo, Lagos State, Nigeria. The participants were divided equally into two groups to receive phacoemulsification and small incision cataract surgeries respectively, their eyes' axial lengths and anterior chamber depths were measured before and after the respective surgical procedures. Unpaired T-test and Paired T-test were employed to analyze data, with the use of the Statistical Package for Social Sciences (SPSS version 22.0).

Results: The paired T-test showed significant changes ($p < 0.05$) with a decrease in axial length and increased anterior chamber depth measurements before and after Phacoemulsification and small incision cataract surgery. However, the Unpaired T-test showed no significant differences when comparing changes in axial length and anterior chamber depth between the two surgical procedures ($p > 0.05$).

Conclusion: Both procedures led to increased anterior chamber depths along with a reduction in axial lengths, nevertheless, the variations between the surgical techniques were not significant.

Key words: Phacoemulsification, Small Incision Cataract Surgery, Axial length, and Anterior chamber depth.

Introduction

Cataract is the leading cause of reversible blindness globally[1] and is the second most common cause of vision impairment and the primary cause of reversible blindness worldwide[2] with a prevalence of around 50% in individuals aged 65-74 years, increasing to about 70% for those over 75 years[3]. The condition is more common in developing nations and populations

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with lower socioeconomic standing[4].

Cataract, described as the opacity of the crystalline lens, is a condition that occurs later in life as one ages[5] and can potentially lead to serious visual impairment or possibly blindness if left untreated[6]. People with cataracts are more prone than the general population to have significantly lower vision-related quality of life, higher mortality, and co-morbidity rates[7]. Surgery can successfully and affordably restore visual loss due to cataracts[8].

The gold standard for cataract surgery in the developed world is phacoemulsification or ultrasonic emulsification of the lens contents, however, manual small-incision cataract surgery (M-SICS) with a self-sealing and suture less incision is frequently employed in low- and middle-income nations. M-SICS and phacoemulsification produce excellent visual outcomes[9,10].

The refractive status of the eye depends on the balance between several variables, including corneal power, lens power, anterior chamber depth, and axial length. It is essential to have a better understanding of how the various biometric parameters relate since taking the biometric measurements of the eye is a vital aspect of the preoperative evaluation of patients to determine the intraocular lens (IOL) power in cataract patients[11].

In achieving the desired IOL power for cataract patients, accurate biometric measurement is vital. The method of biometry involves measuring the cornea's power and the eye's axial length to calculate the appropriate intraocular lens power[12].

The three parameters that determine the refractive power of a human eye are the power of the cornea, the power of the lens, and the axial length of the eye. Using a variety of intra-ocular lens calculating formulae, we may determine the power of the intraocular lens (IOL) required by measuring the aforementioned variables[13].

The goal of cataract surgery has evolved from preserving eyesight to achieving the best possible vision, and it is now a sophisticated refractive technique. By evaluating two commonly used cataract surgery techniques, phacoemulsification, and small incision cataract surgery, on patients' axial length and anterior chamber depth, insights can be gained into the potential differences in surgical outcomes and their impacts on ocular biometry. Understanding the variances in axial length and anterior chamber depth resulting from these procedures is crucial for optimizing surgical decision-making and improving visual outcomes for cataract patients.

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Materials and methods

A convenience sampling technique that involved selecting participants who were readily available and accessible was used. This study was conducted at Adetula Opticals Eye Clinic, Oshodi-Isolo, Lagos State, from June to August 2023, a total population of 90 Individuals consisting of 48 females and 42 males were scheduled for cataract surgery at the study location. These individuals were selected based on their fulfillment of the inclusion criteria for the study which were: patients scheduled for cataract surgery without underlying medical factors that could result in complicated surgical outcomes and were available within the study duration at the study location

The study materials employed were Amplitude scan ultrasound biometry (Nidek US-4000), Disinfectant (70% alcohol), and Anesthetics (0.5% Tetracaine Hcl), and based on predetermined criteria or randomization, patients scheduled for cataract surgery were recruited and assigned to either the phacoemulsification group or the small incision cataract surgery group. The axial length which is the distance between the anterior corneal surface and the retinal pigment epithelium[14] and anterior chamber depth measurements were taken before the surgery using the Amplitude scan ultrasound biometry (Nidek US-4000). After the surgery, a follow-up was scheduled after a week to measure and record changes in axial length and anterior chamber depth.

Ethical consideration: Before this study was conducted, ethical approval was obtained from the Research and Ethics Committee, Department of Optometry, University of Benin with the REC approval number: EC/UBEN/LSC.OPT/23/69. All procedures performed in this study were under the Tenets of the Declaration of Helsinki for human subjects.

Data Analysis: The data obtained from this study were analyzed using the Statistical Package for Social Sciences (SPSS) version 22.0. Descriptive statistics (frequencies, percentages, mean, and standard deviation) summarized the variables. Kolmogorov-Smirnoff test was used to determine the normality in the distribution of data, The paired t-test was used to determine significant differences between variables before and after cataract surgery while the unpaired t-test compared the variables after phacoemulsification and small incision cataract surgery.

Results

A total of ninety (n=90) participants consisting of 48 females (53.33%) and 42 males (46.67) participated in this study, they were divided into two groups of 45, a group was scheduled for phacoemulsification surgery and another for small incision cataract surgery. This distribution indicates a slightly higher representation of females in the study compared to males.

Table 1 presents the mean, standard deviation, standard error of the mean, and the 95%

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confidence interval for each measurement before and after Phacoemulsification and Small incision cataract surgery on the axial length and the anterior chamber depth. The results of this test help to assess if there are significant differences in the changes observed in axial length and anterior chamber depth between the two surgical procedures.

Table 1 Descriptive statistics of measured variables of Phacoemulsification and Small incision Cataract surgery patients

Variable	Mean	Standard deviation (SD)	Standard error (SE)	95% Confidence interval Mean ± 1.96SE
Anterior chamber depth (mm)				
Before Phaco	3.31	0.36	0.05	3.21 - 3.41
After Phaco	3.41	0.36	0.05	3.31 - 3.51
Before SICS	3.26	0.47	0.07	3.12 - 3.40
After SICS	3.35	0.48	0.07	3.21 - 3.49
Axial length (mm)				
Before Phaco	23.91	1.30	0.19	23.53 - 24.29
After Phaco	23.74	1.27	0.19	23.36 - 24.21
Before SICS	23.74	1.02	0.15	23.44 - 24.04
After SICS	23.63	1.00	0.15	23.33 - 23.93

Phaco -Phacoemulsification; SICS – Small incision cataract surgery;

Table 2 Test for normality of distribution of ACD and AL with Kolmogorov-Smirnov Z test

Tests of Normality

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Axial Length (Before)	0.106	90	0.014
Axial Length (After)	0.105	90	0.016
Anterior Chamber (Before)	0.082	90	0.178
Anterior Chamber (After)	0.076	90	0.200*

The results of the test indicated that the anterior chamber measurements before ($p = 0.178$) and after ($p = 0.200$) both cataract surgeries were normally distributed, unlike the axial length with ($p < 0.05$) which shows they were not normally distributed before ($p = 0.014$) and after (0.016) both cataract surgeries. This suggests that the data for anterior chamber depth followed a typical distribution pattern, with the after value of ($p = 0.200$) indicating that the observed outcome is unlikely to have occurred by chance but due to the effect of both surgeries.

TABLE 3: Paired T-test Comparing the Axial Length, and Anterior Chamber Before and After Phacoemulsification Surgery

		Mean Difference	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		P-value
					Lower	Upper	
Pair 1	Axial Length (Before) – Axial Length (After)	0.16844	0.18643	0.02779	0.11244	0.22445	0.000
Pair 2	Anterior Chamber (Before) – Anterior Chamber (After)	-0.10311	0.24075	0.03589	-0.17544	-0.03078	0.006

The paired T-test results showed a statistically significant difference between axial length ($p = 0.000$), and anterior chamber measurements ($p = 0.006$) before and after Phacoemulsification surgery. These results indicate that Phacoemulsification surgery led to a decrease in the axial length and an increase in the anterior chamber depth.

TABLE 4: Paired T-test Comparing the Axial Length, and Anterior Chamber Before and After Small Incision Cataract Surgery

		Mean Difference	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		P-value
					Lower	Upper	
Pair 1	Axial Length (Before) – Axial Length (After)	0.10978	0.16504	0.02460	0.06019	0.15936	0.000
Pair 2	Anterior Chamber (Before) – Anterior Chamber (After)	-0.09267	0.11379	0.01696	-0.12685	-0.05848	0.000

The paired t-test comparing axial length ($p = 0.000$), and anterior chamber ($p = 0.000$) measurements before and after small incision cataract surgery revealed a reduction in the axial length and an increase in the anterior chamber depth after small incision cataract surgery.

TABLE 5: Group Statistics of the Change in Axial Length (AL) and Anterior Chamber (AC) After Different Surgical Methods

	Surgery	N	Mean Difference	Std. Deviation	Std. Error Mean
AL (diff)	Phacoemulsification	45	0.1684	0.18643	0.02779
	Small Incision Cataract Surgery	45	0.1098	0.16504	0.02460
AC (diff)	Phacoemulsification	45	-0.1031	0.24075	0.03589
	Small Incision Cataract Surgery	45	-0.0927	0.11379	0.01696

The group statistics of the change in axial length and anterior chamber after different surgical methods, specifically phacoemulsification and small incision cataract surgery, provide insights into the alterations in these ocular parameters following the respective procedures.

These statistics indicate that both surgical methods led to a decrease in the axial length, with slightly different magnitudes of effect, with phacoemulsification having more impact.

Regarding the anterior chamber, the results suggest that both surgical techniques increased the anterior chamber depth, with phacoemulsification showing a slightly larger change compared to small incision cataract surgery.

Overall, the group statistics highlighted that both phacoemulsification and small incision cataract surgeries led to a decrease in the axial length and an increase in the anterior chamber depth, it also showed that the differences in the mean changes suggest that phacoemulsification may have a slightly larger impact on axial length and anterior chamber depth compared to small incision cataract surgery.

TABLE 6: Unpaired T-test Comparing the Differences in Axial Length (AL) and Anterior Chamber (AC) after the Different Procedures

		Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
AL (diff)	Equal variances assumed	0.118	0.05867	0.03712	-0.01509	0.13243
	Equal variances not assumed	0.118	0.05867	0.03712	-0.01511	0.13244
AC (diff)	Equal variances assumed	0.793	-0.01044	0.03969	-0.08933	0.06844
	Equal variances not assumed	0.793	-0.01044	0.03969	-0.08978	0.06889

The unpaired t-test comparing the differences in axial length and anterior chamber measurements after phacoemulsification and small incision cataract surgery provides a statistical comparison between the effects of these two surgical procedures on these ocular parameters.

For axial length differences, the unpaired t-test results indicated a p-value of 0.118 when assuming equal variances and 0.118 when not assuming equal variances. This suggests that there was no statistically significant difference in the mean changes in axial length between phacoemulsification and small incision cataract surgery groups.

Regarding anterior chamber differences, the unpaired t-test showed a p-value of 0.793, indicating that there was no statistically significant difference in the mean changes in anterior chamber depth between the two surgical methods. These results suggest that both phacoemulsification and small incision cataract surgery had similar effects on axial length and anterior chamber measurements, as there were no significant differences in the changes observed between the two procedures. The unpaired t-test helps compare the outcomes of different surgical techniques and assess whether significant differences in their effects on specific parameters exist.

Discussion

The major cause of blindness worldwide is cataracts, and 90% of those who are blind reside in developing nations[15,16], age-related cataracts (senile cataracts) are the most common cause of lens opacification among the aged population[5].

The study enrolled 90 participants, with a slight majority being female (n = 48; 53.33%) and to ensure the validity of the statistical analysis, Kolmogorov-Smirnov (Table 2) was performed, confirming that the distribution of anterior chamber findings before and after both cataract surgeries followed a normal distribution. This suggests that the dataset was suitable for parametric statistical tests whereas the findings for axial length did not follow the normal distribution which could be as a result of biological variability, therefore understanding the reasons for non-normality can provide insights into future data collection processes.

The analysis revealed statistically significant differences ($p < 0.05$) between various pairs of ocular parameters (Tables 3 & 4), these findings showed an increase in the anterior chamber depth and a decrease in the axial length, following the surgical interventions, these changes indicate that the surgeries affected these ocular parameters. While the significance of these differences does not directly imply a causal relationship or interrelation between the parameters, it does suggest that the surgical procedures led to a decrease in axial length and an increase in anterior chamber depth, unlike the work of Sangkyu[17] which showed in myopic Korean patients, as axial elongation progressed, the vitreous chamber and anterior chamber depths deepened, the corneal central thickness increased but the lens thickness decreased.

Park *et al*[18] also investigated the relationship between axial length (AL) and other ocular parameters. Ocular biometric parameters were measured with an optical biometer, pachymeter, optical coherence tomography, and an automatic refractometer. AL, refractive error (RE), central corneal thickness (CCT), anterior chamber depth (ACD), corneal curvature (CC), white-to-white distance (WWD), and retinal nerve fiber layer (RNFL) thickness were measured, AL, RE, CCT, CC, RNFL decreased, while the mean ACD ($r = 0.506$, $p < 0.001$) and WWD ($r = 0.279$, $p < 0.001$) increased. This was in line with the work of Sangkyu[17].

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Although the analysis revealed statistically significant differences ($p < 0.05$), showing a decrease in axial length changes and an increase in anterior chamber following phacoemulsification and SICS surgeries, it is important to note that there was no significant difference between the changes induced by these two surgical techniques (Table 6). This implies that phacoemulsification and SICS effectively altered axial length and anterior chamber parameters, with similar outcomes regarding these specific measures. This can be attributed to phacoemulsification and small incision cataract surgeries being advanced techniques involving precise cataract removal procedures. The level of precision in both procedures may lead to comparable outcomes in terms of changes in axial length and anterior chamber depth. In both surgical methods, the removal of the natural lens either through a small incision or aspirated using an ultrasonic probe, both techniques created deeper ACD due to the thinner profile of the IOL and subtle changes in the axial length due to surgical factors. These minor variations must be considered to ensure accurate and predictable patient refractive outcomes.

Conclusion and Recommendation

The analysis confirmed the normal distribution of anterior chamber findings before and after cataract surgery, affirming the reliability of the statistical methods for assessing changes in this critical parameter. Importantly, the comparative analysis revealed an increase in anterior chamber depth and a decrease in axial length following each surgery. However, the two techniques were similar in terms of their overall effectiveness. This suggests that both phacoemulsification and SICS are valid and reliable options for cataract surgery, with comparable outcomes in these specific measures.

The choice between phacoemulsification and SICS should consider factors beyond axial length and anterior chamber depth, considering patient demographics, corneal conditions, and surgeon experience. While this research contributes valuable insights, further investigations should delve deeper into additional parameters and factors that influence postoperative outcomes to continue advancing the field of cataract surgery.

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