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Original Research Article

Comparative analysis of central corneal thickness changes after cataract surgery at a tertiary hospital, North Central Nigeria

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ABSTRACT

Background: Cataract surgery is the most frequently performed ophthalmic surgery to restore vision, so it is imperative for any surgeon performing cataract surgery to consider the health status of a cornea, most especially the central corneal thickness and document these parameters pre and post operatively for good visual outcome.
This study aims to assess the effect of conventional extracapsular cataract extraction (ECCE) and manual small incision cataract surgery (MSICS) on central corneal thickness (CCT) in eyes of Nigerian adults with age-related uncomplicated cataract in order to obtain relevant information that will aid in improving cataract surgical outcome.
Methods: This was a hospital based prospective interventional study where all consecutive patients 40years and above with uncomplicated age-related cataract that presented to the hospital and fulfilled the inclusion criteria were recruited into the study until the minimum sample size was obtained. Two hundred and seventy-seven (277) cataract eyes of 269 patients were randomly selected and assigned to either MSICS or conventional ECCE with posterior chamber intraocular lens (PC IOL) implantation. Preoperatively the CCT was measured with a non-contact specular microscope. Post operatively these measurements were repeated at 1 week, 4 weeks and 12 weeks respectively.
Results: Of the 277 eyes studied, 263 (94.9%) were analysed. The mean age of patient for MSICS and ECCE was 64.03 (SD+11.2, range 40–95 years) and 62.69 (SD+10.48, range 42–94 years) respectively with male to female ratio of 1.9: 1. CCT increased in both groups at one week postoperatively but these values returned to preoperative values at 12 weeks after surgery.
Conclusions: The two cataract procedures induced a similar and transient increase in CCT postoperatively with return to normal values at 12 weeks.

Keywords: Cataract surgery, CCT, ECCE, MSICS

INTRODUCTION

CCT is a pivotal parameter that needs to be factored before and after cataract surgery for better visual outcome. Cataract is a major cause of blindness worldwide.[1] Report from the Nigeria national blindness survey, senile cataract account for 43% magnitude of blindness.[2] Cataract surgery is the most frequently performed ophthalmic surgery to restore vision, so it is imperative for any surgeon performing cataract surgery to consider the health status of a cornea and document these parameters pre and post

operatively for good visual outcome. There are different cataract surgical techniques, ranging from intracapsular cataract extraction which is obsolete now, to extracapsular Cataract extraction and modern techniques of manual small incision cataract surgery to phacoemulsification. Recent research reported that phacoemulsification and ECCE, especially MSICS, are safe and effective procedures for optimal visual restoration in cataract patients.[3] Central corneal thickness measurement after cataract surgery is one of the methods used to assess corneal oedema. The commonest cause of corneal edema is any form of cataract surgery with intraocular lens implantation, which happens to be the most commonly performed surgery in the world for treating cataracts.[4]

Corneal edema usually occurs due to endothelial damage during surgery. Most of the causes can be attributed to either patient's factors like pre-existing low endothelial cell density or count prior to surgery, density of cataract and shallow anterior chamber depth or to the surgical procedure and techniques, examples include method of nucleus extraction, effective power time of ultrasound during phacoemulsification technique, type of viscoelastic used, associated surgical complications such as rupture of the posterior capsule with or without vitreous loss.[5-7] This can also occur in secondary glaucoma, peripheral anterior synechiae, chronic iritis following intraocular lens implantation.

Pachymetry is the gold standard method for measurement of central corneal thickness. Is also the common procedure for detecting and diagnosis of corneal edema based on CCT.[8-10] This can be performed using hand held pachymeter or ultrasound pachymeter, however, modern technologies are currently evolving, such as scanning slit topography, confocal microscopy, specular microscopy and spectral oscillation interferometry.[11] Recent study evidence, on the other hand, has shown that OCT is another tool for objectively measuring corneal edema and has become an indispensable tool in clinical practice.[12,13] Normal distribution of CCT is 540+ 30microns (mean+ 1 standard deviation), an increase above 10% of the original pachymetry is an indicator of edema.[4,14,15] Hence, for an average CCT of 550 microns, an increase of 10%, which is 605 microns, after cataract surgery would be indicative of corneal edema.

This study aims to assess the effect of ECCE and MSICS on CCT in eyes of Nigerian adults with age-related uncomplicated cataract in order to obtain relevant information that will aid in improving cataract surgical outcome.

METHODS

The study adhered to the tenant of Helsinki declaration and National Health Research Ethics Committee. The study was carried out at National Eye Centre Kaduna, Nigeria, for a period of one year from July 2017 to July 2018. Ethical approval was obtained from the Ethical Committee of the hospital. Written and informed consent was sought and obtained from all patients, after explanation of the nature of the study which was given in detailed. Informed consent for the study and consent for surgery was obtained from all patients that fulfilled the inclusion criteria. This was a hospital based prospective interventional study where all consecutive patients 40 years and above with uncomplicated age-related cataract that presented to the hospital and fulfilled the inclusion criteria were recruited into the study until the minimum sample size was obtained.

Annually, forty thousand, one hundred and seventy (40,170) patients are seen at the study area in the various sub-speciality clinics of the hospital. Of these one thousand five hundred and fifty-five (1,555) patients (Adults and children) underwent surgery. Fifty percent (50%) of these (741) were adults aged 40years and above with age related cataract. The minimal sample size was determined by using the following formula.[16]

$$nf = \frac{n}{1+\frac{n}{N}}$$

Where nf = the desired sample size when population is <10,000

n=the desired sample size when population is >10,000

N=the estimate of the population size

(NB- n was obtained from the following formula- $\frac{Z^2pq}{d^2}$

$$n = \frac{(1.96)^2 \times 0.50 \times 0.50}{(0.50)^2} = 384$$

Where Z= The standard normal deviation usually set at 1.96 which corresponds to the 95% confidence level.

p=The proportion in the target population estimated to have a particular characteristic. If there is no reasonable estimate, then 50% (0.50) should be used.

q=1.0- p

d=Degree of accuracy desired, usually set at 0.05 or occasionally at 0.02).

Thus $nf = \frac{n}{1+\frac{n}{N}} = \frac{384}{1+\frac{384}{741}}$ (total number of adult eyes with cataract)

= 252, adding 10% of non-response (25) gives overall total of 277 eyes.

Where Z= The standard normal deviation usually set at 1.96 which corresponds to the 95% confidence level. P= The proportion in the target population estimated to have a particular characteristic. If there is no reasonable estimate, then 50% (0.50) should be used.

All patients aged 40 years and above with uncomplicated age-related cataract, planned for either ECCE or MSICS and Consent to participate were included in the study. Patients who presented with signs suggestive of corneal

disease e.g. pterygium, dystrophies, infective keratitis or corneal guttata, acute/chronic uveitis, previous history of ocular trauma or surgery, contact lens wear, history of glaucoma or raised IOP, high myopia with cataract, pseudo exfoliative syndrome, eyes that failed to dilate due to presence of posterior synechea, eyes that were included but subsequently had posterior capsule rupture+ vitreous loss with or without anterior chamber lens insertion and failure to give consent, were all excluded from the study.

All patients aged 40 years and above with aged related cataract in one or both eyes that presented to the clinic were recruited for the studies for duration of one year. Data recorded were age, sex and telephone number for easy communication with the patients. Detailed history of presenting complaint, duration of visual loss, associated ocular pains, previous history of ocular trauma, chronic ocular surface disease (suggested by recurrent history of itching, tearing, photophobia, dryness, discharge (3 or more episode of these symptoms in the last one year), previous history of contact lens wear or symptoms suggestive of recurrent / chronic uveitis (blurring of vision, redness, floaters etc), positive history of glaucoma or systemic diseases like diabetes mellitus.

Preoperative and postoperative examinations were carried out in the clinic includes- visual acuity (VA) taken using the Snellen tumbling E chart at distance of 6 meters, those that could not read the chart at that distance were tested at distance of 3 and 1 meters respectively and also with use of pen torch for perception of light along with pupillary light reflex. Those that were found to have nil perception of light (NPL) and relative afferent pupillary defect (RAPD) were excluded from the studies.

A complete pre-operative ophthalmological examination including anterior segment biomicroscopy to examine the cornea for clarity, presence or absence of corneal oedema, corneal ulcers, opacity, keratic precipitates and pigment deposit, anterior chamber clarity, presence or absence of flare and cells, iris transillumination, iris pigment deposit, shape and pupillary reaction, presence or absence of synechea were all noted. Intraocular pressure was measured using the Goldmann applanation tonometer (GAT) and all eyes with raised IOP >24 mmHg were excluded from the studies. Pre- operative CCT was measured with non-contact specular microscope (SP 02, CSO). Slit lamp biomicroscopy of the posterior segment with + 78D non-contact lens was performed after adequate pupillary dilatation. Eyes with cup disc ratio >0.8 or other evidence of glaucomatous damage were excluded. Eyes that failed to dilate due to presence of posterior synechea or showed evidence of lens subluxation were excluded from the studies.

Informed consent for the study and consent for surgery was obtained from all patients that fulfilled the inclusion criteria. They were randomly assigned to have either of the two surgical procedures. The patients were asked to pick any one of the two sealed brown envelopes containing type of the surgical procedure (either MSICS with PC IOL or ECCE with PC IOL) in the anaesthetic room. The choice of type of surgical procedure was then disclosed to the surgeon by the anaesthetic nurse who opened the envelope picked by the patient. Surgery was performed by one experienced consultant Ophthalmologist. Post-operative CCT was assessed serially using the non-contact specular microscope (SP 02, CSO) at one week, 4 weeks and 12 weeks respectively. Those that missed more than one follow-up visits were excluded from the study. One proforma was filled for each operated eye of patients that had surgery in both eyes. Apart from the cost of surgery all other procedures were at the expense of the researcher.

Surgical procedures

Both procedures (conventional ECCE and MSICS), were carried out in the operating theatre under sterile condition by a single most experience cataract surgeon.

Pre-medication with oral acetazolamide 500 mg stat at 6am on the day of operation was given to all patients.

Extracapsular cataract extraction

Patient's eye was cleaned and draped in supine position under 5 mls of peribulbar local anesthesia (LA). Conjunctival peritomy extending from 10- 2 o'clock hour was performed, followed by a partial thickness limbal incision, obtaining about 2/3rd of total sclera thickness from 10-2 o'clock. Anterior chamber (A/C) was entered into with the tip of the blade. Viscoelastic was injected into the A/C. Can-opener technique anterior capsulotomy using 27G needle as a cystitome was performed. The partial thickness limbal incision was completed with universal corneal scissors. The nucleus was expressed out with alternating superior and inferior pressure using Vectis. Soft lens matter was aspirated with infusion-aspiration simcoe cannular. The A/C was reformed with viscoelastics. IOL was inserted into the posterior chamber capsular bag. The wound was sutured using the interrupted suture technique with 10/0 nylon. The viscoelastic substance was aspirated from the A/C using the infusion aspiration simcoe cannular. The A/C was then reformed with Ringer's lactate. Intra-operatively subconjunctival genticin 20 mg and dexamethasone 2 mg was given. A drop of topical dexamethasone 0.1%, mydriacyl 1%, maxifloxacin eye drops were instilled and the eye padded.

Manual small incision cataract surgery with posterior chamber intraocular lens implantation

Patient's eye was cleaned and draped in supine position under LA. Conjunctival peritomy performed from 10-2 o'clock positions. Conjunctiva and tenon's capsule were dissected and separated from the underlying sclera. Homeostasis was achieved by applying gentle wet field cautery. External scleral incision obtaining one third to half thickness sclera was made about 2mm from the limbus and 5.5 mm in length in straight configuration. Scleral-

corneal tunnel was made with the crescent knife and extended about 1.5 mm into the clear cornea. Internal corneal incision was made with a sharp 3.2 mm angled keratome. Side-port entry of about 1.5 mm valvular corneal incision was made at 9 o'clock position using 150 side port entry blade. The anterior capsulotomy was performed followed by hydrodissection. Corneal wound was extended on either side. Nucleus was prolapsed into the A/C and delivered using Vectis by direct pulling. Soft lens matter was aspirated using a two- way irrigation and aspiration simcoe cannular.

A/C was reformed with viscoelastic substance. PC IOL was implanted into the capsular bag. Viscoelastic substance was then aspirated. The wound was closed after deepening the A/C with Ringer's lactate solution, using the two-way irrigation aspiration simcoe cannula through the side-port entry. Subconjuctival injection of dexamethasone 2mg and genticin 20 mg was given and a drop of topical dexamethasone 0.1%, mydriacyl 1%, maxifloxacin eye drops were instilled and the eye padded.

Postoperative treatment for the above two procedures included- gutt dexamethasone 2 hourly for 72 hours, then four times daily thereafter, gutt maxifloxacin four times daily, gutt mydriacyl twice daily, tabs cataflam 50 mg twice daily for 5 days. All ocular medication were given for a minimum of 6 weeks, thereafter steroids were tailed off while others were discontinued.

Statistical analysis

Data obtained were entered into microsoft Excel and analyzed using SPSS software version 20.0, Chicago II USA software.

Tests of statistical significance

One sample t test was used to compare pre-operative and postoperative values within a group. Independent t test was used to compare the values between ECCE and MSICS. P value of <0.05 was considered significant. Limits of agreement (LoA), (95%CI) was calculated.

RESULTS

A total of 277 eyes of 269 patients were recruited for the study over a period of one year. Fourteen eyes of fourteen patients were excluded from the analysis because one was found to have raised IOP >24 mmhg after the surgery, two had intra operative complications, while 11 were lost to follow-up. Two hundred and sixty-three (263) eyes were included for analysis, 8 of them were bilateral (3 males, 5 females), 100 right eyes and 147 left eyes. One hundred and forty-six (55.5%) eyes had MSICS with PC IOL while 117 (44.5%) eyes had conventional ECCE with PCIOL. Over all 229 eyes completed the 3 months follow-up visits, while 34 eyes lost one follow-up visit. Seven eyes were part of the ECCE group and 27 were MSICS group (1 was absent at 4 weeks, 33 were absent at 3 months follow-up period). Table 1 shows the age sex distribution of the study population-The mean age of patients who underwent MSICS and ECCE was 64.0, (SD+11.2, range 40-95years) and 62.7 (SD+10.48 range 42-94years) respectively. Males accounted for 65.8% and females 34.2%. M: F ratio of 1.9: 1. The mean IOP was 14.9mmHg in the RE and 15.1 mmHg in the LE.

Table 2 shows the base line pre-operative characteristics of the two groups. It was observed that there was no statistically significant difference in the preoperative mean age (p value 0.319, CI -3.38 to 1.3), mean IOP (p value 0.259, CI -0.36 to 1.4), mean central corneal thickness (p value 0.272, -17.7 to 5.0) between the two group.

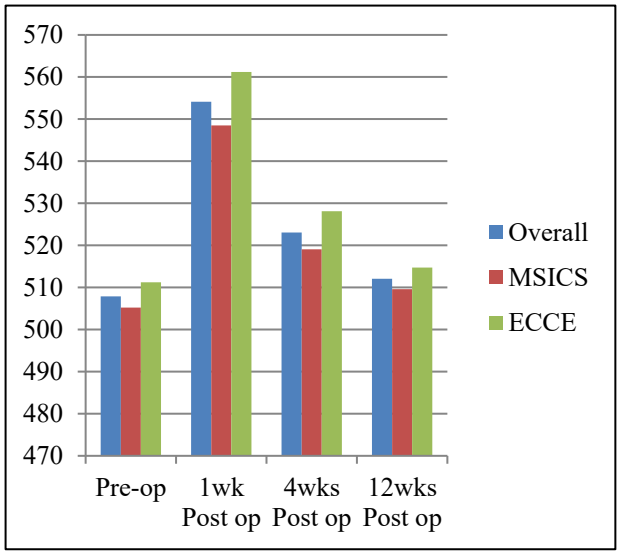

Figure 1: Postoperative mean central corneal thickness in the two groups.

Central corneal thickness

The mean preoperative pachymetry CCT was 505+43µm in the MSICS group and 511+42µm in the ECCE group, the difference was not statistically significant (p=1.103, 95% CI=-17.7 to 5.04). At 1 week, the mean increase in corneal thickness was 43µm in the MSICS group (p<0.0001, 95% CI=540 to 556, t=140) and 50 µm in the ECCE group (p< 0.0001, 95% CI=552 to 570, t=124). At 4 weeks, the increase was 14µm in the MSICS (p<0.05, 95% CI=512 to 525, t=150) and 17µm in the ECCE group (p<0.05, 95% CI=520 to 536, t=132). At 12 weeks, the increase was 4 µm (p=0.491, 95% CI=502 to 516, t=143) and 3 µm (p=0.480, 95% CI=520-536, t=139), in the MSICS and ECCE group respectively. There was no statistically significant difference in the change of mean corneal thickness between the overall and the two groups during the follow up period (p=0.022, t=-2.325, CI=-23.70 to -1.90). Figure 1 shows the increase in mean CCT during the postoperative period in the overall and between the two groups. A progressive increase was observed in all and was more marked during 1st week postoperative period.

Table 1: Age sex distribution of the study population.

Age group (in years)	Sex		Total No. %
	Male No. %	Female No. %	
40-49	12 (6.9)	6 (7.0)	18 (6.8)
50-59	53 (30.6)	21 (23.3)	74 (28.1)
60-69	59 (34.0)	38 (42.0)	97 (36.9)
70-79	30 (17.3)	11 (12.2)	41 (15.6)
80-89	17 (10.0)	12 (13.3)	29 (11.1)
≥90	2 (1.2)	2 (2.2)	4 (1.5)
Total	173 (65.8)	90 (34.2)	263 (100)

Table 2: Preoperative characteristics of the two groups.

Group		MSICS	ECCE	P Value	CI
Pre-op characteristics					
Age (in years)		64±11	62±10	0.319	-3.98 to 1.3
Sex	Male	97 (eyes)	76 (eyes)	0.063	-
	Female	49 (eyes)	41 (eyes)	-	-
Total		146 (eyes)	117 (eyes)	-	-
IOP (mmHg)	RE	14.3±2.8	14.8±2.8	0.259	-0.36 to 1.4
	LE	14.5±2.8	15.1±2.9	0.194	-0.28 to 1.4
Pachymetry (µm)±SD		505±43	511±42	0.272	-17.7 to 5.0

All values in mean±SD, ECD.

DISCUSSION

The two groups studied in this research (MSICS and ECCE group) were found to have similar preoperative characteristics with respect to age, sex, mean IOP and central corneal thickness. Ninety four percent (94.9%) completed two or more follow up visits which probably was due to the effort made to contact patients on phone as a reminder for the appointment. Sixty five percent (65.8%) of the patients were males, probably due to gender inequality where female patients have poor access to cataract surgical services particularly in this part of the developing world.[17,18]

Corneal thickness significantly increased in both groups one week post operatively, after which it recovered to pre-operative values. Some authors have reported that all their patients regained pre-operative values after 4 weeks.[19] The results of this study was in contrast to findings by Aribaba et al where both their pre and post operative CCT values were higher than in the study, this difference may be as a result of differences in ethnic and geopolitical background, their study population were predominantly Yorubas from south western part of the country and ours were mainly Hausa/Fulani from North west region, despite the fact that study was carried out in the same country.[20] The mean increase in post operative CCT was also lower in this study compared to Aribaba et al, this may be attributed to differences in response to inflammatory reactions between the two different ethnic groups.[20] The recovery period was observed to be similar to that of Aribaba et at findings where the CCT values return closely to pre operative values at 12 weeks post operatively.[7] Study by Kongsap reported similar results to ours, where the first day after surgery, the cornea, initially 531 microns thick, increases to 603 microns (an average increase of 73 microns) and thickness returned to normal 1 month after the surgery.[21] Similarly, Deshpande et al showed that in manual small incision cataract surgery, the mean CCT on day 7th postoperative day increased from 509 microns baseline to 528 microns and on day 30th was 514 microns.[22]

MSICS is one of common surgical procedure for cataract, especially in the developing world where phacoemulsification is very expensive to carry out. Many large randomized controlled studies reported that both phacoemulsification and the MSICS techniques are safe and effective for visual rehabilitation of cataract patients.[23,24] However, MSICS might have advantages over phacoemulsification in the management of difficult cataract.[25] MSICS is also more economical and most cost-effective cataract surgical intervention in developing countries.[26] Some authors reported, CCT increased by 8.2% at 1 week postoperatively (from 538±34 µm to 582±56 µm, p=0.0001), by 3% at 1 month and by 0.2% at 3 months postoperatively, these changes are also similar to our own study with return to near preoperative values at 3 months postoperatively.[27]

Limitations

Non-availability of modern phacoemulsification machine. Lack of enough funds to assist all patients with incentive to cover for transport and feeding during the study period.

CONCLUSION

It has been found that all types of cataract surgical technique induced some form of corneal oedema with resulting increase in corneal thickness which may eventually affect the patient visual outcome, however this can be minimize by careful minimal surgical manipulation and improve surgical expertise.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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