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Evaluation of Astigmatism Induced by Cataracte Surgery: 330 Cases. At The Sainte-Yvonne Ophtalmological Clinic in Lubumbashi (Democratic Republic of Congo)

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ABSTRACT

Cataract is a public health problem in post-conflict underdeveloped countries such as the Democratic Republic of Congo, and the astigmatism induced is an economic burden for this same population. The aim of this study is to contribute to improving the management of cataract surgery patients.

This is a descriptive, longitudinal, analytical study, which included 330 eyes of 238 adult patients aged 50 or over. Study variables: gender, age, type of procedure, eye involved, history, axial length, astigmatism, visual acuity, implant power, tunnel size, limbus distance, type of procedure (phacoalternative: PHACO A, phacoemulsification: PHACO E). Percentage, mean, standard deviation, Ficher's exact test, Chi-square, relative risk and 95% confidence interval were calculated.

Patients aged between 70 and 79 years predominated (37%), with a sex ratio of 1.4 men. The mean value of surgically induced astigmatism (SIA) at D1 (DAY 1) was 1.9±1.8 D. And 57.6% of cases had an induced astigmatism < 1.7 D. For phacoemulsification at D30: 73.8% of cases had a mean surgically induced astigmatism < 1.7 D. And for phacoalternative at D30: 50.2% of cases had mean surgically induced astigmatism ≥ 1.7 D; and at D90 phacoalternative: 63.2% of patients had mean <1.8 D astigmatism.

Induced astigmatism is an element influencing the functional outcome of cataract surgery, Induced astigmatism proves low in the majority of cases; although our functional results without correction remain below the threshold set by the World Health Organization.

Keywords
Induced astigmatism, Cataract, Phacoalternative, Phacoemulsification.

Introduction

Cataract is the world's leading cause of reversible blindness. During cataract surgery, the main incision is made along a given axis, and induced astigmatism is defined as a flattening effect induced along this axis. The World Health Organization (WHO) recommends that all cataract surgeons evaluate their own results over time, and identify the causes of poor results. Addressing these causes can improve cataract surgery outcomes in the future [1,2].

According to the study by Hiep et al. cataract surgery-induced astigmatism:1.50 D in 22.2% of cases. And around 38% of cataract eyes had a preoperative astigmatism of 1.00D before surgery [2]. Diallo et al. In Burkina-Faso in 2015, by PHACO A. The mean induced astigmatism was 1.12±1.26D [3]. Ngabou et al. In CONGO-BRAZZA in 2019 had found induced astigmatism of 1.37 D [4]. However, we were unable to find any data in the literature on studies published in the Democratic Republic of Congo dealing with induced astigmatism. Measuring this parameter is the choice and interest of our study. Cataracts are a public health problem. The astigmatism induced by cataract surgery is an economic burden, mainly due to the daily replacement of spectacles by our patients.

Can reducing induced astigmatism improve functional results after cataract surgery?

Can phacoalternative surgery provide functional results comparable to phacoemulsification in our setting?

Methodology

We conducted a longitudinal descriptive and analytical study with prospective data collection, at the Clinique ophtalmologique Sainte Yvonne, carried out from February 20 to August 30, 2023.

Sampling was non-probabilistic and exhaustive, involving 330 eyes of 238 adult patients with a cataract operable by PHACO A and/or PHACO E.

Inclusion Criteria

adult patient with a diagnosis of cataract and aged 50 or less, patient elected for surgery by PHACO E and/or PHACO A with superior approach, patient to be operated on who had had keratometry measured preoperatively, patients who had had the visits scheduled by the study, patients who had benefited or not from incision suturing and retrobulbar anesthesia, patients who had given informed consent to participate in the study.

Non-inclusion Criteria

Patients aged under 50, eyes with an axial length greater than 28mm or less than 18mm, patients with keratometry greater than 52D and less than 36D and those whose keratometry did not draw, patients with post-traumatic cataract, post uveitis, with major intra and postoperative complications, patients with corneal pathology, those lost to follow-up were subsequently excluded.

The superior curvilinear incision, with scleral tunneling, was performed for PHACO A patients. A coaxial micro-incision and a second (lateral) 3.2 mm keratome incision (3.0 mm) were used for PHACO E. Keratometry was measured preoperatively on the morning of surgery, then postoperatively on D1, D10 and D30 for PHACO E, and on D90 for PHACO A.

Keratometry values were measured: K1 was assigned to the vertical meridian and K2 to the horizontal meridian.
Pre-op astigmatism (K1pre-op - K2pre-op) and post-op astigmatism were recorded (K1post-op-K2post-op).

Induced astigmatism =|(K1post-op -K2post-op)-┤ (K1pre-op-K2pre-op)|┤ according to the method of Reddy.

Study Variables

Qualitative variables: gender, type of procedure, eye involved and general and ocular history; quantitative variables: age, axial length, astigmatism, intraocular pressure (IOP), visual acuity (VA), implant power (IOL), incision length, incision distance limbus; dependent variables: Induced astigmatism; Independent variable: Type of intervention.

Data Analysis and Statistical Tests

For qualitative variables: Absolute frequency and percentage; for quantitative variables: mean, standard deviation, minimum and maximum; statistical tests: Chi-square test, p value at 0.05 significance level and relative risk with 95% CI.

Ethical Considerations

We obtained the approval of the medical ethics committee of the University of Lubumbashi under the number UNILU/CEM/132/2022 and maintained the anonymity and confidentiality of the data.

Results

During our data collection period, 774 eyes were operated on, including 551 cataract cases.
Cataract, of which we included 330 eyes of 238 adult patients.

Socio-Demographic and Clinical Variables

The incidence of PHACO A and E surgically induced astigmatism was 42.6%, the age range of our patients varied from 50 to 92 years, the mean age of our patients was 66.5 years with a standard deviation of 9.2 years, the 70 to 79 age group was the most represented with 37%. Male patients predominated (58.2% vs. 41.8%), with a sex ratio of 1.4 in favor of males; the majority of patients (32.7%) came from the Lubumbashi commune; most patients (78.2%) had no general medical antecedents; 11.5% of our patients were diabetics and 10.3% hypertensives; the most common ocular antecedents were glaucoma (3%) and 27.9% pseudophakic.

The majority of our patients had preoperative visual acuity ≤ 1/10

in 87.9%, against 12.1% with visual acuity > 1/10. According to WHO functional evaluation criteria (uncorrected visual acuity is good when it ≥ 3/10 in 80% of cases), at D30 uncorrected visual acuity (VA) PHACO A and E was 54.2% of cases or VA≥3/10. On D30 PHACO E: good uncorrected VA represented 64.5%, i.e. VA≥3/10. At D30 PHACO A: best uncorrected VA 49.3% i.e. VA≥3/10. At D90 PHACO A: VA without correction 59.6% or AV≥3/10 of cases. The evolution of visual acuity according to World Health Organization criteria on D0, D1 and D30 for the two surgical techniques is described in Table 1. The table shows that 2.1% of patients had visual acuity ≥3/10 compared with 68.5% of patients with VA<1/10 preoperatively, and 54.2% had better VA compared with 10.6% with poor AV on D30 postoperatively. The distribution of patients according to the eye concerned was almost equitable, but with a slight predominance of the right eye (51.2%) and the left eye (48.8%). We used PHACO A more often: 68% versus 32% of patients operated on with PHACO E. The posterior chamber intraocular implant in 59.7% of cases was ≥ +21.75 D, minimum value of +11D and maximum of +25.5 D and mean of +21.7±1.9 D; the available intraocular implant in 51.8 of cases≥ +21.2 D, minimum value of +12 D, maximum of +25 D, mean of +21.2±1.8 D. In 125 cases (37.9%) the implant matched the biometrically calculated power, in 205 (62.1%) the implant did not, the implant mismatch had a difference ranging from - 4 to + 3 D. The majority of our patients had an axial length varying between 21 and 24 mm in 91.2% of cases; minimum of 20.4 mm and maximum of 27 mm, mean of 22.9±0.8 mm.

Table 1: Distribution of patients according to uncorrected visual acuity at D0, D1, D30: (according to World Health Organization PHACO A AND E criteria).

Visual acuity	D0 (%)	D1 (%)	D30 (%)
≥3/10	7(2,1)	120 (36,4)	179 (54,2)
<3/10 ≥1/10	98(29,7)	124 (37,6)	116 (35,2)
<1/10	225 (68,5)	86 (26,1)	35 (10,6)
Total	330 (100,0)	330 (100,0)	330 (100,0)

Calculation of Cataract Surgery-Induced Astigmatism

Patients were divided into 3 classes according to their preoperative astigmatism: low astigmatism from 0 to 1.99 D, medium astigmatism from 2 to 3.99 D, high astigmatism ≥ 4D and also according to the mean. Mean preoperative astigmatism was greater than or equal to 1.3 D in 69.1% of cases. The distribution of patients according to preoperative astigmatism into low, medium and high is described in Table 2. The majority of our patients had a low preoperative astigmatism of 0 to 1.99D in 85.8% of cases. Induced astigmatism was calculated at Day (D1), D10, D30 for PHACO E and then at D90 for PHACO A and divided equally into 3 classes and the mean.

Table 2: Distribution of patients according to preoperative astigmatism.

Preop astigmatism	Number	Percentage
Low astigmatism	283	85,8
Medium astigmatism	33	10
Strong astigmatism	14	4,2
Total	330	100

Here we report the results: At D30 PHACO A and E. Sixty-three point nine percent of our patients had low induced astigmatism: 0-1.99 D. At D30 PHACO E: the majority of patients operated on with PHACO E, i.e. 80.4%, had low astigmatism, with an average < 1.7 D in 73.8% of cases. At D30 PHACO A: 56.1% had low astigmatism and an average ≥ 1.7 D in 50.2% of cases. At D90 PHACO A: our patients had low astigmatism in 63.7% of cases and a mean < 1.8 D in 63.2% of cases.

The distribution of patients according to low, medium and high induced astigmatism (PHACO A and E) is shown in Table 3. Table shows that 85.8% of patients had low astigmatism preoperatively, 63.6% on D1, 62.7% on D10 and 63.9% on D30, versus 4.2% with high astigmatism preoperatively, 14.2% on D1, 9.7% on D10 and 7.0% on D30. However, the majority of our patients had low astigmatism overall.

Table 3: Distribution of patients according to induced astigmatism (PHACO A and E).

Astigmatism	Astigmatism J0	Astigmatism J1	Astigmatism J10	Astigmatism J30
Low astigmatism	283 (85,8)	210 (63,6)	207 (62,7)	211 (63,9)
Medium astigmatism	33 (10,0)	73 (22,1)	91 (27,6)	96 (29,1)
Strong astigmatism	14 (4,2)	47 (14,2)	32 (9,7)	23 (7,0)
Total	330 (100,0)	330 (100,0)	330 (100,0)	330 (100,0)

Factors Associated with Induced Astigmatism

Intraoperatively, the majority of patients operated on with PHACO A (74.4%) had no suture, conjunctival approximation accounted for 8.5% and scleral suture for 17.0%. The length of the upper incision in PHACO A patients ranged from 8.1 to 10 mm in 50.2% of cases, 7 to 8 mm in 42.6% and over 10 mm in 7.2%. The mean distance between incision and limbus was 2.5 mm, with a minimum of 2 mm and a maximum of 3 mm.

Evaluation of The Impact of Surgery on The Risk of Astigmatism

Patients who underwent PHACO A had a 2.024-fold risk of having induced astigmatism at Day (D1) ≥1.9 compared with patients who underwent PHACO E. There was an association between mean induced astigmatism at D1 and types of surgery (CI [1.368-2.994]). Patients who underwent PHACO A had a 2.639-fold risk of having induced astigmatism at D10 ≥1.8 compared with patients who underwent PHACO E. There was an association between mean induced astigmatism at D10 and procedure types (CI [1.739-4.004]).

Distribution of patients by relative risk, confidence interval and type of intervention at D30 (n=330): Patients who underwent PHACO A had 1.919 times the risk of having induced astigmatism at D30 ≥1.7 compared with patients who underwent PHACO E. There was the association between mean induced astigmatism at D30 and procedure types (CI [1.361-2.707]).

Table 4: Distribution of patients by relative risk, confidence interval and type of intervention at D30 (n=330).

Types of surgery	Induced astigmatism Average D30		Total
	< 1,7	≥ 1,7	
PHACO. A	111	112	223
PHACO. E	79	28	107
Total	190	140	330

Bivariate Analysis

There was no association between induced astigmatism J90 PHACO A and suture type (X^2 : 4.735, ddl : 4, p : 0.316). The association between induced astigmatism J1 PHACO A and incision length was statistically significant (X^2: 19.881, ddl: 4, p: 0.001). The association between induced astigmatism J90 PHACO A and incision length was statistically significant (X^2: 9.713, p: 0.046). There was no association between induced astigmatism at J90 PHACO A and limbal incision distance (X^2: 3.927, p: 0.416). There was no association between astigmatism induced at D30 PHACO A and E and postoperative D30 VA (X^2: 18.028, p: 0.704).

Distribution of patients by type of procedure and induced astigmatism at D30 (PHACO A and E): The association between induced astigmatism at D30 and type of procedure was statistically significant (Chi-square: 22.600, p: 0.0000).

Table 5: Distribution of patients by type of procedure and induced astigmatism D30.

Types of surgery	Induced astigmatism J30			Total
	Low astigmatism	Medium astigmatism	Strong astigmatism	
PHACO. A	125	75	23	223
PHACO. E	86	21	0	107
Total	211	96	23	330

Discussion

The limitations of our study include the failure to assess corrected visual acuity in all patients, the use of equipment such as the TOP CON KR-8900 auto kerato-refractometer, and the failure to use appropriate implants intraoperatively in relation to the power calculated by biometry. However, the prospective collection of data, the measurement of keratometry and biometry in all patients, calculation of preoperative, postoperative and induced astigmatism, assessment of induced astigmatism and uncorrected visual acuity between the two techniques are highlights of our study.

Patients ranged in age from 50 to 92 years. The average age of our patients was 66.5 years, an identical finding observed [5]. In Lubumbashi in the Democratic Republic of Congo in 2019: age range was 59 to 79 years or 53.27% with an average age of 64±14.5 years, Sekera JLM et al. [1]. In Kinshasa in 2019: 64 years; Diallo et al. In Burkina-faso in 2015 [3]: 66 years, Yorston et al. [6]. In KENYA in 2002: 64 years. Averages of 60 and 62 were found respectively by Sheoran et al. [7]. in 2022 and Djiguimde et al. in Burkina-Faso in 2015 [8]. These mean ages of around 60 can be explained by the population of senile and presenile patients in the various studies.

According to the present study, there was a predominance of males (58.2%) versus 41.8% of females. The sex ratio was 1.4 in favor of men. Male predominance was also reported [1]. In Kinshasa in 2019: 60.7%. Sex ratio 1.5; Diallo in 2015 [3]: 57%, sex ratio 1.36. Other studies found different results, notably Nday B K F et al. [5]. In Lubumbashi in 2019: sex ratio of 1.1 in favor of women; MBA AKI et al. [9]. In Gabon in 2019; Ngabou et al. [4]. In Congo Brazza in 2019 with a female predominance and a sex ratio of 0.90 for each. DJIGUIMDE et al. [8]. In Burkina-Faso in 2015, sex ratio of 0.98.

The majority of our patients, 87.9%, had visual acuity ≤1/10 preoperatively for both types of surgery. MBA AKI et al. [9]. In Gabon in 2019 who used phacoemulsification on nearly half of their patients, recruited better preoperative visual acuities:67.90% ≤ 1/10. Using the phacoalternative technique and conventional extra capsular extraction (EEC), Koffi et al. [11] in 2015, SOWAGNON et al. [12] in 2014 and OLAWOYE et al. [13] in 2012 had found respectively 94.74%, 97.25% and 93.30% of patients with visual acuity less than or equal to 1/10th. On postoperative day 30, 54.2% of our patients had the best uncorrected VA (≥3/10ths). Our uncorrected visual results are below WHO guidelines, which could be explained by patient selection, refractive vices and operative technique and biometry calculation. Our result is close to that of Djiguimde et al. [8] in 2015. Who found 57.7% of patients with better visual acuity without correction at postoperative D 45. Diallo et al. [3] in 2015. Found 67.83% of cases with AV ≥3/10th at postoperative day 30. According to the World Health Organization (WHO) the best AV (≥3/10) for PHACO A at D30 represented 49.3% and 64.5% for those with PHACO E. This proportion is well below that of Mba Aki et al. [9] in 2019. Who reported 75.4% of cases of good visual acuity without correction in patients operated on by Phaco A and 81.8% for phaco E.

The best VA (≥3/10) without correction for PHACO A at D90 represented 59.6% of cases this rate is lower than that found by Diallo et al. [3]. In 2015, good visual acuity without correction was observed in 74.22% of cases at 60 days post-op. The minimum axial length was 20.4 mm and the maximum was 27 mm, the mean was 22.9 ± 0.8 mm This observation is similar to that of Djiguimde et al. [8]. Burkina-Faso in 2015, who found an average of 22.8 mm, The axial length of our patients was within normal limits. The mean preoperative astigmatism value was 1.3D±1.1 D. In most cases (85.8%), it ranged from 0 to 1.99 D (low astigmatism). Our mean value was close to that of NGANGA et al. [4]. In 2019 who found 1.37 D. DIALLO in 2015 had found 0.87 D.

Fifty-six point one percent of patients operated on with PHACO A had low induced astigmatism at D30. The mean was 1.7 D. Our results are not similar to those of Narinder Kumar et al. [14] in 2022. Where after 4 weeks, (62%) patients had an astigmatism between 0 and 1.0 D, and his mean value of postoperative astigmatism at 4 weeks was 1.18 D. This difference would be explained by the fact that the upper incision was routinely performed in all patients.

According to Thakre U D et al. [15] in 2023, 54% had a surgically

induced astigmatism (SIA) between 1.5 and 2.5 D, and 32% had an SIA greater than 2.5 D. Only 14% had an SIA less than 1.5 D at one month. Only 14% had an SIA of less than 1.5 D at one month. This difference may be explained by the fact that in our study the intervention was performed by specialists, as opposed to the residents mentioned in the study by Thakre U D et al. [15]. At D90, 63.7% of PHACO A patients had low astigmatism. The mean was 1.8D. according to Thakre U D et al. [15] in 2023, Archana S Nikose et al. [16] in 2018: 52% had an SIA between 1.5 and 2.5 D, at the end of 3 months, in contrast Reddy B et al. [17]. Found at D90 for the small incision cataract surgery (SICS) group by superior incision an astigmatism against the rule of 1.93±0.53 D on average and 1.57±0.24 D for the temporal incision on average as the astigmatism of the rule. The majority of our PHACO E patients (80.4%) had low astigmatism on the thirtieth postoperative day, with an average of <1.7 D in 73.8% of cases. For Reddy B et al. [17] in 2007 at D90, the mean was 1.08±0.36 D for clear corneal incisions and 1.23±0.71 D for scleral pocket incisions.

In contrast, Yoon, JH et al. [18] in 2013 performed phacoemulsification through a 3 mm temporal and nasal clear corneal incision with a foldable IOL. They reported that the temporal incision induced less AIC than the nasal incision. They found that the mean SIA in the temporal group after 1 month was 0.81 ± 0.64 D, while in the nasal group it was 0.92 ± 0.53 D. SIA decreased after 3 months to 0.53 ± 0.39 D in the temporal group, whereas it was 0.92 ± 0.53 D. 0.62 ± 0.48 D in the nasal group. In our work, the tunnel was created without prior measurement, based on the surgeon's experience, and measured at the end of the procedure. The length of the upper incision in PHACO A patients ranged from 8.1 to 10 mm in 50.2% of cases. The average was 8.7 mm This length varied from study to study, the average incision size was 7.2 mm, with extremes of 7 to 10 mm for Thakre U D et al. [5]. In 2023. The distribution according to incision length was as follows: 36 (72%) patients had a length ≤ 7.0 mm, while nine (18%) had it between 7.1 and 8.0 mm, and five (10%) had a length greater than 8 mm.

In our study, the mean distance between incision and limbus was 2.5 mm, with a minimum of 2 mm and a maximum of 3 mm in the majority of cases, i.e. 56.2%, the distance was 2 mm. Our results are not superimposable with those Thakre U D et al. [15] in 2023: 28 (56%) patients had a limbus distance ≤ 1.0 mm, while 18 (36%) had a distance between 1.1 and 1.5 mm and four (8.0%) had a distance ≥ 1.5 mm [19-21].

Conclusion

Cataract surgery remains the most frequently performed ophthalmic procedure, and one of its modern objectives is to minimize induced astigmatism. The functional outcome of cataract surgery is a motivating factor for our community populations to undergo surgery, and induced astigmatism is an element influencing the functional outcome of cataract surgery.

Our study showed that the astigmatism induced by the two surgical techniques, PHACO A and PHACO E, was acceptable, and that the good functional result generated was more in favour of PHACO E, even though it was below the threshold set by the World Health Organization, and the lower the induced astigmatism, the better the functional result. This study also provided us with a clinical and analytical epidemio-profile focusing on the study of the following variables: age, sex, general ocular and cataract surgery history, preoperative and postoperative visual acuity, axial length, implant power, induced astigmatism, incision length and limbal incision distance; the varied and bi-varied analyses carried out enabled us to note the achievement of our specific objectives and answer our two research questions with satisfaction. The association between induced astigmatism at J90 PHACO A and incision length was statistically significant, while there was no association between induced astigmatism at J90 PHACO A and limbal incision distance. This study also reveals a strong statistically significant association between induced astigmatism and procedure types, with PHACO A patients having 2 times the risk of induced astigmatism ≥ 1.7 D compared to PHACO E patients. Thus, to achieve WHO functional evaluation criteria, we suggest a technique based on the limbal relaxation temporal curvilinear scleral incision of 6 to 8 mm in length without suture. However, we were unable to find any data in the literature on studies published in the Democratic Republic of Congo and dealing with induced astigmatism. The measurement of this parameter motivates the choice and interest of our subject and constitutes an innovative contribution in our study environment. Our results could be improved by the acquisition of an IOL Master 700 and the purely analytical study of induced astigmatism.

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