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Deleterious Impact of Non-Diabetic Cataract Surgery on the Values of Biomarkers of Oxidative Stress and Metabolic Syndrome in Kinshasa

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Abstract

Study Background and Purpose: Cataract is considered a structural marker of systemic metabolic disorders. Its association with metabolic syndrome (MS) and oxidative stress has only been well established in diabetic patients. The objective of the present study was to evaluate the impact of non-diabetic cataract surgery on biomarkers of SM and oxidative stress according to the pre-post operative phases.

Material and Methods: This was a mixed study, a consecutive series combining an intervention (quasi-experimental study before and after cataract surgery), a documentary study (patient file), a comparative and evaluative approach involving 163 patients over the age of 40, during a period from September 1 to December 31, 2022 at the MASINA Ophthalmological Center. Nominal variables were presented as frequencies, while quantitative variables as means ± SD. Pearson's Chi-Square test and Yates' Chi-Square test were used to compare the proportions between two groups. The threshold for statistical significance was set at any value of P<0.05.

Results: Of a total of 163 patients, 60.1% (n=98) were men versus 39.9% (n=65) women. Nearly 81.6% (n=133) of the patients were of an advanced age-Senior ≥ 60 years old. Cataract surgery very significantly induced a deleterious impact on the rest of the components of the metabolic syndrome/insulin resistance-oxidative stress-atherosclerosis: the increase in mean BMI values (23.7 ± 4.1 vs 32.8 ± 5.4; P<0 .0001), CT (124.9±46.5 vs 279.6±88.7 mg/ dL ; P<0.0001), LDL (94.5±34.1 vs 191.4±65.9 mg/ dL ; P<0.0001), TG (90.7± 45.9 vs 200.6±73.9 mg/ dL ; P<0.0001) and glycaemia (92.7±8.1 vs 101.8±10.6 mg/ dL ; P<0.0001) in the postoperative phase being higher than those of the before surgery while the mean values of PAS, PAD, HDL and Albumin (P<0.0001) of the postoperative phase were lower than those of the phase before cataract surgery. Biomarkers of insulin resistance and atherogenicity were very significantly higher after cataract surgery: TYG (8.2±0.5 vs 9.2±0.4; P<0.0001), CT/HDL ratio (2.6±1.1 vs 16.9±28 ; P<0.0001), LDL/HDL ratio (1.93±0.8 vs 11.5±19.8; P<0.0001), TG/HDL ratio (1.8±0.9 vs 11.7±25.4; P<0.0001), Non HDL (74.9±48.3 vs 247.4 ±102.4mg/ dL ; P<0.0001).

Conclusion: The present study confirmed that cataract is a structural marker of systemic disorders and a state of pre-hypertension, pre-diabetes, pre-atherosclerosis and oxidative stress in Bantu patients. A multidisciplinary postoperative follow-up is necessary.

Keywords: Cataract; Surgery; Biomarkers; Metabolic Syndrome; Oxidative Stress; Insulin Resistance; Kinshasa.

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Introuduction

Traditionally, cataracts have been a huge global health burden [1,2]; it is characterized by the presence of lens opacity and by different pathological forms [1,3].

Epidemiological data highlight the prevalence, risk factors and predictors of medico-social complications characteristic of cataract in wealthy countries with modern surgical techniques and procedures [3,4]. Among the risk factors for cataracts, there is age, any age in general but especially advancing age, more vulnerable than congenital-infant age, arterial hypertension, excessive alcohol consumption, active smoking, diabetes mellitus, myopia, uveitis, glaucoma and certain medications (corticosteroids)[5,6]. Thus, the literature has also incriminated cataract as a component of the metabolic syndrome (diabesity including type 2 diabetes mellitus, abdominal/visceral obesity, arterial hypertension and dyslipidemia [7,8].

In the Democratic Republic of Congo (DRC), fragmentary (hospital) [9] and animal model [10] studies report the frequency of traumatic complications linked to the cataract itself and to cataract surgical techniques. Identifying and treating modifiable risk factors could not only reduce the risk of cataract formation but also improve postoperative functional prognosis [2,11].

The general objective of this study was to evaluate the impact of non-diabetic cataract surgery on pro-oxidant, pro-inflammatory-metabolic biomarkers according to the pre- and post-operative phases.

Methods

Study design and framework

It was a mixed study, consecutive series combining an intervention (quasi-experimental study before and after cataract surgery), a documentary study (patient file), a comparative and evaluative approach between the months of September and December 2022 at the Ophthalmological Center of MASINA.

Study population: Non -diabetic patients with cataracts, aged over 40, who consulted the Masina Ophthalmological Center (COM) during the study period were our target population. Included in this study: any non-diabetic patient with a clinical and ophthalmological diagnosis of cataract followed and operated on at the COM, having carried out a preoperative and postoperative biological assessment including the dosage of Triglycerides, total cholesterol, HDL-cholesterol , LDL-cholesterol, albumin, and having consented freely, during the period of our study. The following were excluded from the study: all patients operated on for cataract recognized as diabetic; all patients operated on for cataract without biological assessment; all non-consenting cataract patients.

The general formula for calculating the sample size (Ni) considered the following values: Incidence (P= probability, estimated proportion=0.92); Q= 1-P=1-0.08; Z alpha = Standard deviation equal to 1.96 for α (risk of concluding that there is a difference that does not actually exist) =0.05; D= tolerated margin of error=0.04. Thus ($Z\alpha = Z^2xQ(1-Q)/D^2$ = 170 participants.

Data collection: It was done on the basis of an ad hoc data collection sheet. A patient interview was conducted by the principal investigator for 30-40 minutes to collect epidemiological, environmental and health data.

Body weights (kilo) were measured to the nearest 100 grams in lightly dressed and barefoot patients on a Seca scale , previously calibrated each morning, on a flat and stable surface. Height (m) was measured using the height gauge near Cm.

All participants benefited from a complete, detailed ophthalmological examination defined as follows**:** gross and corrected visual acuity (VA) measured with standard optotypes, on the Monnoyer scale for educated patients and optotypes Snellen E for participants with a low level of education (illiterate); examination of the general anterior segment and the lens in particular, according to the Van Herick method , carried out using the Haagstreit 900 brand biomicroscope (Switzerland); the measurement of the intraocular pressure carried out using a Goldmann applanation tonometer and estimated in mmHg; examination of the fundus by the direct method using a Heine beta 200 ophthalmoscope (Germany).

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) measurements were respectively recorded on the arm, along the path of the humeral artery, previously detected using the tip of the index finger. , middle finger, ring finger in patients who had been comfortably installed for 10 minutes in a seated position (mmHg); using the sphygmometer with mercury height.

Regarding the biological profile, the values were repeated before and after surgery. Fasting blood glucose was measured in plasma using the ONE TOUCH glucometer to confirm or refute the absence of diabetes mellitus after fasting blood glucose.

CT, LDL-C, HDL-C, Albumin and triglycerides were assayed by the same Biochemistry laboratory of the University Clinics of Kinshasa, on serum, from whole blood without anticoagulant, taken between 7 a.m. and 10 a.m., at the ulnar vein of the fasting participant. The assays were performed by the semi-automatic clinical chemistry analyzer (Mindray).

Definitions of concepts and operational definitions:

Senility/aging characterized frailty in patients ≥60 years old (senior or elder) versus adulthood = 40-59 years.

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This quasi-experimental/interventional study included the following phases of the perioperative period:

The preoperative phase included the evaluation of the patients by the anesthesiologists and the cataract surgeon with the normal values of SBP, DBP, CT, HDLc , TG and blood glucose (Bio markers) on Day 1;

The postoperative phase evaluated the directions of the variations of the biomarkers towards the increase, the stability and the decrease after cataract surgery between D1 and D30 of the metabolic syndrome complex, circulating biomarkers-inflammation-atherogenicity-pro-oxidants.

Hypoalbuminemia was defined by albuminemia < 35 g/L which reflected protein -energy malnutrition, inflammation, immune deficiency.

Atherogenicity: Non-HDL Cholesterol is the differential between total cholesterol and HDLc , it summarizes the sum of the two potentially atherogenic fractions of cholesterol, namely LDL cholesterol and HDL [12]. In patients considered to be at high cardiovascular risk, this level is between 130 and 159 mg/ dL . The Triglyceride- Glucose index (TyG Index) makes it possible to determine insulin resistance; it is a more effective biomarker than its separate components for identifying abnormalities in Glucose metabolism [13]. Its normal value is set at 8.5. The total/HDL cholesterol ratio is used to measure cardiovascular risk. Its normal value should be < 5 [13]. HDL/LDL; TG/HDL ratio ≥ 2.5, Triglyceride-Glucose Index and Body Mass Index (TyG -BMI) is a simple, powerful and clinically useful surrogate marker for early identification of insulin resistance [14,15].

A body mass index (BMI) ≥25 Kg/m² and ≥30 Kg/m² respectively define overweight and obesity.

The Metabolic Syndrome (SM) was defined according to NCEP-ATP III by the presence of at least 3 of the following criteria: PA≥130/85 mmHg, TT>83 Cm, Fasting blood sugar >126 mg/dl, HDL-c <40 mg/ dL , triglyceride >150 mg/ dL [16].

Statistical analyses: Data were entered using Excel 2016 software, and analyzed using IBM SPSS 26 software.

For the descriptive and comparative approaches before and after cataract surgery, the univariate analyzes considered the nominal variables (qualitative or categorical) in the form of frequencies (n= effective) and proportions (%) while the quantitative variables/ (saltatory or continuous) were presented as means ± SD, minimum and maximum. Pearson's Chi-Square test and Yates' Chi-Square test were used to compare the proportions between two groups. The trend chi-square function was used to calculate the odds ratio (odds ratio=OR) and biological exposure gradients (causal association criterion) between ≥3 groups. Student 's t-test was used to compare mean values of normally distributed (symmetric) variables between two groups. Analysis of variances (ANOVA) compared mean values of symmetric variables between ≥ 3 groups. The mean values of the asymmetric variables were compared between two groups according to the nonparametric test of U (the rank sum) while the nonparametric Kruskal test was used to compare the mean values between ≥3 groups.

For the evaluative approaches for the intervention Before-After cataract surgery, the proportions of the phase After cataract surgery (Y = second measurement), were compared to those of the phase Before cataract surgery (X = first measurement) according to the statistical test, non-parametric alternative of MC Nemar.

$$K= (AB)^2 /A+B.$$

For quantitative variables, the bet t-test (t-test) was used to compare the paired sample means of the two variables for a single group (non-diabetic, non-hypertensive cataract patients before–after). Indeed, this procedure calculated the differences between the values of the two variables for each observation and tested whether the mean differs from 0.

Statistical inference: Statistical inference was interpretative according to the following steps:

The hypothesis formulated was zero (H0 = no difference between two variables); Consider the likelihoods of the observation under the hypothesis H0 for the value of the probability P<0.05 (degree of statistical significance).

Ethical considerations: This study carried out in patients obtained the approval of the National Ethics Committee of the Democratic Republic of Congo under number N°376/ CNES/BN/PMMF/2022 of August 4, 2022 and in compliance with the recommendations of the Declaration of Helsinki III (declaration-Helsinki-1964-2015-08-20).

Results

The variables of interest were presented before and after cataract surgery; the univariate and multivariate analyzes considered the comparisons of the mean values and the proportions of the variables of interest in a quasi-experimental/before-after intervention manner. The extent and determinant of the incidence of Visual Impairments (VI) were presented postoperatively.

General characteristics of the population

Age

In this study population, the average age was 72 ± 10 years, with extremes ranging from 50 to 88 years (Figure 1).

Sex

Out of a total of 163 patients, a male predominance was found with 60% (n=98) against 40% (n=65) of women. The sex ratio was close to 2 Male: 1 Female (Figure 2).

Nkolomonyi CM, et al., J Opthalmol Res 2023
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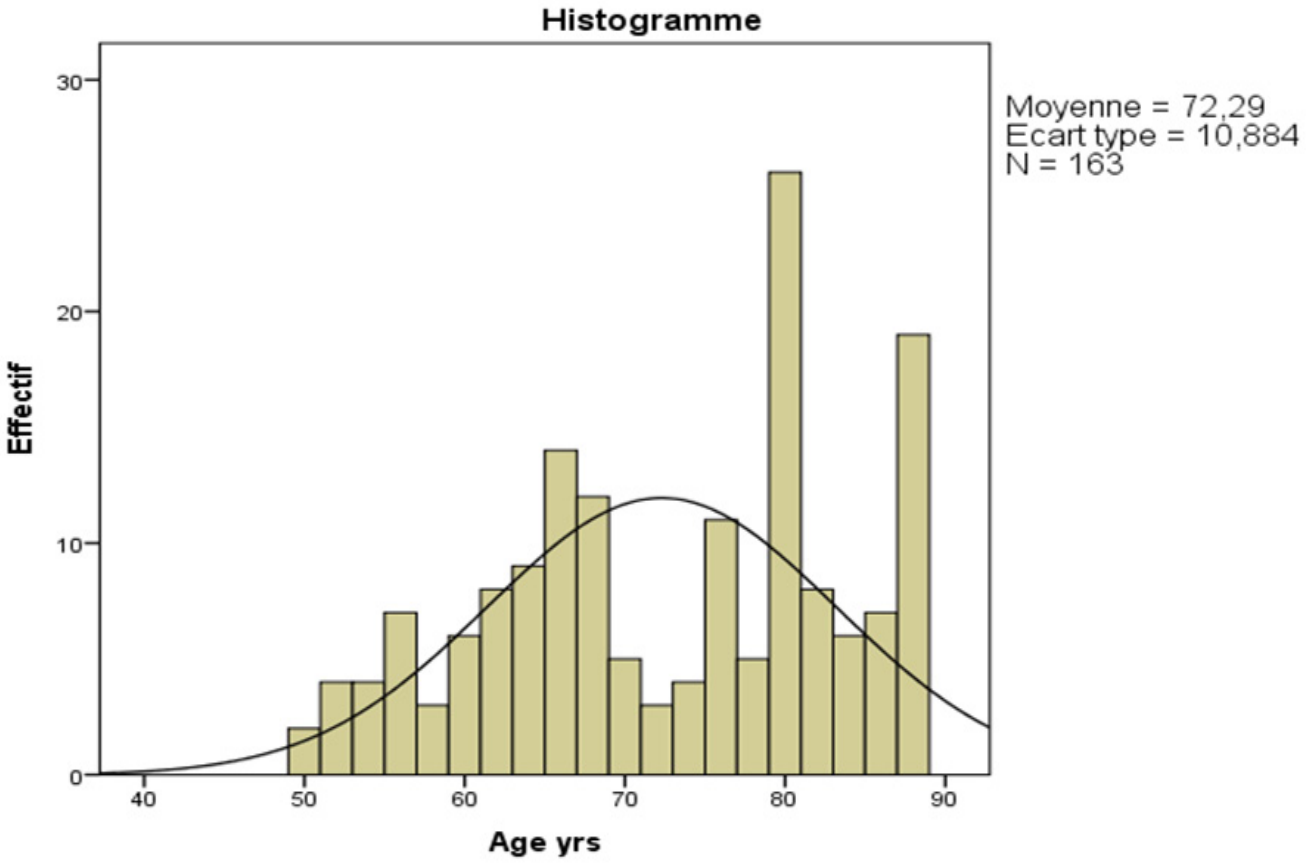

Figure 1: Distribution of the population according to age

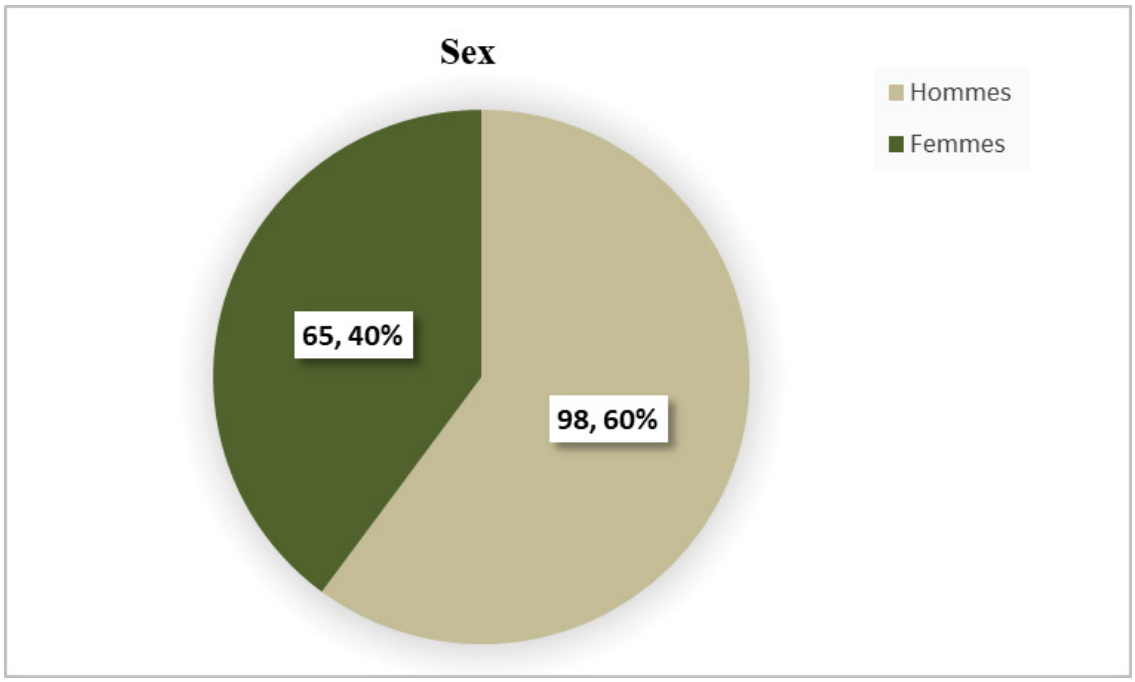

Figure 2: Distribution of patients by sex.

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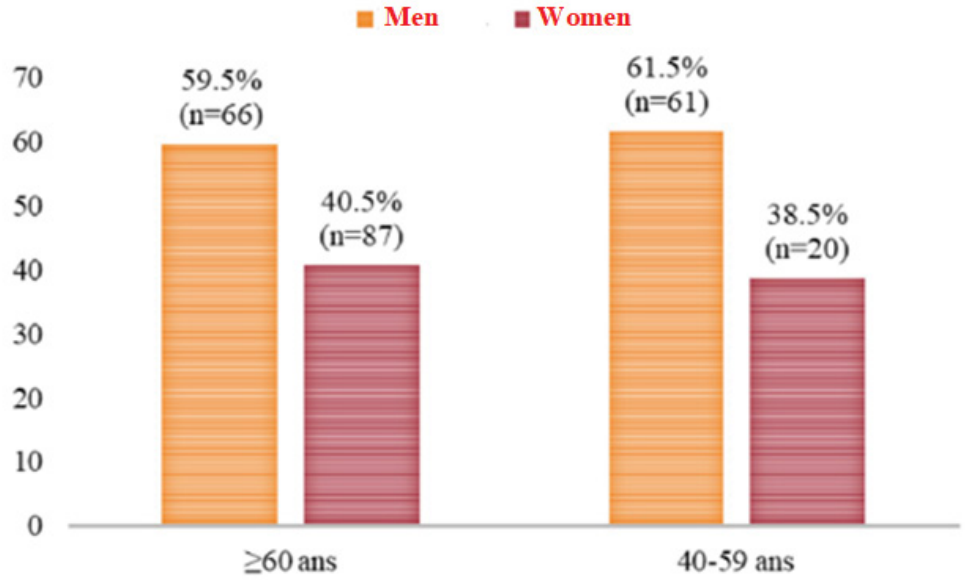

Figure 3: The study population distribution according to gender and age

The age distribution of all patients was normal (symmetrical) despite its multimodal appearance. Nearly 81.6% (n=133) of patients were of an advanced age-Senior ≥ 60 years against nearly 18.4% (n=30) of patients whose age was < 60 years adult in the total population (Figure 3).

Comparative approaches for the values of structural-circulating markers of cardiometabolic risk before and after surgery

Except for TT, cataract surgery very significantly induced a deleterious impact on the rest of the components of the metabolic syndrome/insulin resistance-oxidative stress-atherosclerosis: the increase in mean values of BMI, CT, LDL, TG and glycemia in the postoperative phase being higher than those of the phase before cataract surgery while the average values of PAS, PAD, HDL and Albumin of the postoperative phase were lower than those of the phase before cataract surgery (Table 1).

Atherogenicity indices

All insulin resistance and atherogenicity biomarkers were very significantly higher in the post cataract surgery phase than during the pre-surgery phase (Table 2).

Discussion

This section recalled the object relating to the pejorative impact of surgery on structural-circulating markers before and after cataract surgery.

Contrary to the data of the literature with a neutral influence of the sex in the presence of cataract, the present study carried out in Kinshasa (western of the DRC), a study recently carried out in Lubumbashi (South-East of the DRC) [13], a Nigerian study (West Africa) and one carried out in Greece [13] rather incriminate the male predominance in cataract according to a sex ratio of 2 men: 1 woman. It is difficult to think of a causal association in the absence of a prospective study and confounding factors related to accessibility to care, education and higher care in men than in women in the DRC.

This study looked at non-diabetic cataract patients with an advanced age, similar on average to the average cataract age of 62 years in Mali and the average age of 64 years for cataract patients in Nigeria [17]. But considering age ≥ 60 years, nearly 82% of cataract patients in the present study were far higher than 74% in Mali [18] and 72% in Lubumbashi[13]. It is the currently high life expectancy in Africa explained by the demographic transition and by vaccination, the fluorescent economic development despite the socio-economic and politico-military crises. Overall, the present study confirmed the meaning of SM in patients with cataract [13]: Nearly 95% of patients admitted for cataract surgery had SM specific to Sub-Saharan Africa (TT≥81 Cm) [2]. But if it were necessary to consider the TT≥ 80 Cm, 100% of the patients of the present study would present the SM according to IDF [2]. Indeed, SM is characterized by a constellation of several biomarkers and structural markers that increase the risk of cardiovascular disease, type 2 diabetes mellitus, and stroke [9].

SM-Insulin resistance-atherosclerosis-inflammation-oxidative stress-for cataract set after surgery

In the present study, cataract surgery exaggerated the proportions of Hypo-albuminemia (Inflammation, oxidative stress and protein -energy malnutrition) [19], hypo HDL-cholesterolemia (inflammation-oxidative stress), high levels of CT/ HDLc , LDLc / HDLc , Non HDLc (Atherosclerosis-cardiometabolic risk) and IR-TYG (Biomarkers currently approved as insulin resistance) [13].

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By ruling out the confounding variables (Age, TT, PAD, HDLc , LDLc , TG, Glycemia, Albumin, CT/ HDLc , TYG, LDL/ HDLc and non- HDLc), the rise in BMI (specific structural markers of subcutaneous regional adiposity in the Bantu)[20], here the decrease in SBP (vaso-constriction reactive to haemorrhage and component of tissue hypoperfusion) and dyslipidemia defined by the increase in total cholesterol (bad cholesterol pro atherosclerosis is incriminated in visual disturbances) remained significantly associated with non-diabetic cataract.

The study by Heydari B et al. [21,22] showed that hypercholesterolemia, hypertriglyceridemia, elevation of LDL-C and blood sugar levels are significantly associated with the presence of cataracts. As these authors pointed out, the results of the present study plead in favor of the development of health promotion activities in our environment, in order to control these modifiable factors within populations at risk.

Indeed, cataracts are associated with elevated serum CT, LDL-C, and TG levels, all of which are components of Metabolic Syndrome (MS). And in the present study, cataract surgery was accompanied by an explosion in the levels of structural markers and circulating biomarkers of SM, oxidative stress, inflammation as well as indices of atherogenicity. In addition, cataract surgery exaggerated oxidative stress with depletion of albumin (antioxidant biomarker) and HDL-C (pro-oxidant biomarker) levels[8]. Several studies have demonstrated the role of oxidative stress in the occurrence and maturation of cataracts, even in experimental models [23,24].

Furthermore, elevated blood glucose levels may be a phenomenon involved in the failure of the antioxidant enzyme system and the progressive peroxidation of lipids [25,26], even after cataract extraction.

On D30, the patients in this study presented a significant increase in the levels of BMI, total cholesterol (TC) and triglycerides (TG). The observation of an explosion of obesity, cholesterol and particularly TG has already been reported in a population of patients after heart transplantation [27,28] with persistence of high levels of TG beyond a follow-up of 3 years. In liver transplant patients, Yi Wu et al. [22,29] in China found that elevated TG levels predicted the onset of type 2 diabetes.

Overall, patients operated on for cataract can be considered to be in a state of pre-diabetes, as shown by the results of the present study, with a very high cardiovascular risk, requiring multidisciplinary follow-up in the immediate and distant postoperative period. .

To date, two hypotheses could be put forward in view of the results of this study:

- first, the effect of functional recovery on the behavior or eating habits (excessive consumption) of patients operated on for cataract;

- the influence of the degree of satisfaction of patients after cataract surgery on their lifestyle (sedentary lifestyle) following good functional recovery.

The present study had a degree of limitations related to the absence of inflammation biomarkers like CRP protein, oxidized LDL (oxidative stress), hyperthyroidism test, urinary examination (nephrotic syndrome, vomiting, Diarrhea, lupus) in front of the hypoalbuminemia. On the other hand, the strengths of the present study reside in the first result of a quasi-experimental approach (intervention before after cataract surgery) according to the calculation of the size of the sample and mathematical models (matched sample and rigorous discriminant analysis). Thus, temporality (time) in a longitudinal manner/monitoring demonstrated the causality of the exaggeration of the SM-Insulin resistance-Atherogenicity-inflammation-oxidative stress complex [20].

Conclusion

The present study confirmed that cataract is a structural marker and a pre-hypertension, pre-diabetic, pre-atherosclerotic state in poor Bantu patients.

Gender and age had no impact on the SM-insulin resistance-inflammation-atherosclerosis-oxidative stress components.

Overall, cataract surgery exaggerated SM-insulin resistance-inflammation-atherogenicity-oxidative stress components.

Further longitudinal studies should be conducted to elucidate these findings and explore the variations of these biomarkers beyond D30.

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