Background: Corticocapsular adhesions (CCA) are frequently seen between lens capsule and adjacent cortical layer. During cataract surgery, in the presence of CCA, excessive efforts to rotate the nucleus can result in zonular damage. To reduce morbidity, identification of associations with CCA can be helpful in appropriately modifying the surgical procedure.

Aim: To investigate probable associations with CCA in patients undergoing cataract surgery.

Setting and Design: Iladevi Cataract and IOL research center. Case-control study.

Materials and Methods: A single eye of 600 patients, 200 patients with CCA (cases) and 400 patients without CCA (controls) were considered. A CCA diagnosis was based on: (i) preoperative presence of CCA on slit-lamp examination with visualization of furry surface of cortex during surgery; (ii) preoperative absence of CCA on slit-lamp examination but intraoperative visualization of furry surface of cortex. Variables such as age, gender, type of cataract, grade of cataract, high myopia, diabetes mellitus and hypertension were studied.

Statistical Analysis: Multivariate logistic regression was done. Results were presented as odds ratio (OR) with 95% CI.

Results: Mean age was 64.71 ± 9.10 years in cases and 59.27 ± 8.79 years in controls. Presence of CCA increased with age from 22% (n = 59) in 45 to 49 years to 70% (n = 110) in 70 to 79 years. An increase in age was associated with CCA by 3.3% (OR = 3.3%, P = 0.028). The odds of CCA for females were 83% higher (P = 0.027).

Presence of anterior cortical cataract increased odds of CCA by 9.5 times (P = 0.001), while posterior cortical cataract increased odds by 3.3 times (P = 0.001).

Conclusion: Corticocapsular adhesions were strongly associated with cortical cataracts, increased age and female gender.

Key words: Cataract, corticocapsular adhesions, hydrodissection, multiquadrant hydrodissection

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Introduction

Corticocapsular adhesions (CCA) occur between the lens capsule and the adjacent cortical layer [Figs. 1 and 2]. They resemble cortical opacities, which often cannot be broken by a single hydrodissection.¹ The operating surgeon should consider the presence of CCA during cataract surgery. This is because when CCA are present, nucleus rotation during cataract surgery is not only difficult but may prove to be impossible as well.¹ Furthermore, unsuccessful efforts to rotate the nucleus due to the presence of CCA can even result in zonular stretch or damage. In eyes with CCA, forceful rotation of the lens is likely to result in a break in the integrity of the capsular zonular complex.¹ When CCA are present, we strongly recommend performing a judicious combination of multiquadrant and focal hydrodissection to cleave these adhesions apart and remove a major obstacle to phacoemulsification.¹ Thus, identification of factors associated with the development of CCA can be helpful in appropriately modifying the surgical procedure so as to reduce morbidity. Keeping these in mind, the present study was designed to evaluate the probable associations with CCA.

Materials and Methods

This was a single observational case-control study undertaken at our clinic during the period April 2004 to November 2004. Healthy eyes with uncomplicated cataracts in the age group of 45 years onwards were included in the study. Eyes with coexisting ocular pathology, traumatic cataracts, previous ocular surgeries, pupil ≤6 mm that precluded full dilation and persons in whom slit-lamp lens evaluation was not possible were excluded from the study.
In this prospective case-control study, we decided on a sample size of 200 patients with CCA (cases) based on our earlier study, which reported a 30% incidence of CCA. To achieve the target of recruiting 600 patients for the study, we examined 760 consecutive patients with cataract who were scheduled for surgery within the stipulated period [Flow plan 1]. For analysis there were 580 patients, 189 patients with CCA (cases) and 391 patients without CCA (controls).

Each patient signed a consent form before enrolling in the study. All the patients were subjected to a thorough slit-lamp examination. Each eye was dilated with 1% tropicamide eye drops three times at 15-min intervals or till the pupillary dilatation was 7 mm or more in diameter. A trained single observer recorded the observations for each eye for the presence and severity of specific lens opacity. The procedure for assessment of cataract in the present study is described here. The type of cataract was categorized in the following manner: T1: nuclear, T2: anterior cortical, T3: posterior cortical, T4: posterior subcapsular cataract (PSC). Grading of nuclei based on degree of hardness was done according to the Emery T4: posterior subcapsular cataract (PSC).

Presence of CCA was documented with the slit-lamp at 12× magnification with maximum illumination and the slit beam focused on the capsule at a 30° to 45° angle. Corticocapsular adhesions appeared as an opacity in the outermost layer of the cortex with no visible area of translucence between the capsule and the underlying opaque cortical layer [Fig. 2]. However, during slit-lamp examination, cortical cataract should be differentiated from CCA. In cortical cataract, a distinct area of translucence is always visible in the inner substance of the lens [Fig. 3].

A single surgeon did phacoemulsification under topical anesthesia using a standardized surgical technique. After capsulorrhexis, either single site corticocleaving hydrodissection or, if nucleus rotation was not possible, additional focal and multi-quadraned hydrodissection was performed. A deep central tunnel was sculpted and the nucleus was divided into multiple small fragments using the step-by-step chop in situ and lateral separation technique. The fragments were emulsified using the stop, chop, chop and stuff technique and the step down technique. In soft cataracts, nucleotomies were performed after sculpting followed by fragment removal by phacoaspiration. Intraoperative confirmation of CCA was further done by visualization of a furry surface of cortex during residual cortex removal.

The following criteria were applied to eyes to consider their inclusion as cases: (i) preoperative presence of CCA on slit-lamp examination with visualization of furry surface of cortex during surgery; (ii) preoperative absence of CCA on slit-lamp examination but intraoperative visualization of furry surface of cortex. A trained person, who was unaware of the status of the participants in terms of cases and controls, collected the data. The associations were documented for CCA. The associations evaluated were age, gender, type of cataract, grade of nuclear sclerosis, pathologic myopia and presence of diabetes mellitus.

Statistical analysis

Considering the fact that various factors coexisted and there was interdependence between them, to assess the probability of occurrence of CCA with changes in independent variables, multivariate logistic regression analysis was adopted. The dependent variable occurrence of CCA was dichotomous, with Code 0 for nonoccurrence and Code 1 for occurrence of CCA. The associations evaluated were age, gender, type of cataract, grade of nuclear sclerosis, pathologic myopia and presence of diabetes mellitus. SYSTAT statistical package (Version 8.0) for Windows (SPSS, Chicago, IL, USA) was used for statistical analysis.

Results

We could predict the presence of CCA correctly in 98% of our population. All cases fulfilled our first inclusion criterion. The mean age of the subjects was 64.71 ± 9.10 years (range 40 to 88 years) in cases and 59.27 ± 8.79 years (range 40 to 77 years) in controls. Of 580 patients, 318 were males and 262 females. Of 318 male subjects, 93 (29.2%) had CCA; of 262 female subjects, 96 (36.6%) had CCA. Table 1 represents the incidence of CCA by age and gender in cases and controls. In the age group of 40 to 49 years (n = 59), 22% had CCA while in the age group of 70 to 79 years (n = 110), 70% had CCA. As age increased the occurrence of CCA also increased [Table 1]. Multivariate logistic regression analysis, after adjusting for the impact of other factors, revealed that the probability of occurrence of CCA increased by 3.3% with advancing age (OR = 3.3%, P = 0.028), while the odds of CCA for females was 83% higher than that for males (P = 0.027). Table 2
shows the prevalence of different types of cataracts in cases and controls. Owing to the prevalence of mixed cataracts in 96% of eyes with CCA, for the purpose of analysis, type of cataract implicated the presence of opacity irrespective of the coexistence of other types. There were 17 eyes with Grade 5 nuclear sclerosis in cases, while none in the control group. Owing to the small and unequal sample size, the 17 eyes were grouped as Grade 4 factor in the CCA group. Table 3 shows the incidence of CCA in cases and controls based on type of cataract (alone or in combination), grade of cataract, pathological myopia and presence of diabetes mellitus. Table 4 shows the multivariate analysis. For logistic regression, the model pseudo R square represented by Nagelkerke $R^2$ square.
was 0.604, which was strong enough and the overall correct prediction was 84.8%. Presence of anterior cortical cataract increased the odds of CCA by 9.5 times ($P = 0.001$), while the presence of posterior cortical cataract increased the odds of CCA by 3.3 times ($P = 0.001$). There was no association between grade of cataract and CCA. Diabetes mellitus showed a weak association with CCA. An increase in the axial length by 1 mm reduced the odds of CCA by 12% ($P = 0.029$). Presence of cortical opacity emerged as a significant factor contributing to the increased risk of CCA. A comparison of the incidence of cortical opacities in the CCA group with respect to age and gender is shown in Table 5. In eyes with cortical opacities (n = 255 patients), 65.5% had CCA (167/255). Of the 167 patients with CCA, there were 106 females over 55 years (63.5%). In the present study, 138 patients had diabetes and 442 patients did not have diabetes. Of the 138 patients with diabetes, 71 patients (51.4%) had cortical cataracts. Of these, 64 patients (90.1%) had CCA. While in the 442 patients without diabetes, 268 patients (60.6%) had cortical cataracts. Of these, only 121 patients (45.1%) had CCA.

### Discussion

In an initial pilot study we had reported the incidence of CCA as 20% in 180 consecutive patients undergoing phacoemulsification. Later, in a prospective study, 264 patients scheduled for phacoemulsification were preoperatively assessed for the presence of CCA and the incidence was found to be 30.3%. In the same study, the presence of CCA was found to be a significant factor producing a snag during phacoemulsification. Increased awareness about the condition and diligent efforts to notice the same could probably be the reason for the increased detection of CCA. Corticocapsular adhesions are probably rarely seen in industrialized countries.

### Table 3: Comparison of risk factors in cases and controls

| Variable                  | Cases (n = 189) | Controls (n = 391) | Total (n = 580) |
|---------------------------|----------------|-------------------|-----------------|
|                          | No. (%)        | No. (%)           |                 |
| Nuclear cataract          | 159 (30.8)     | 358 (69.2)        | 517             |
| Anterior cortical cataract| 167 (65.5)     | 88 (34.5)         | 255             |
| Posterior cortical cataract| 142 (73.6)   | 51 (26.4)         | 193             |
| Posterior subcapsular cataract| 139 (38.6) | 221 (61.4)        | 360             |
| Grade 1                   | 42 (40.4)      | 62 (59.6)         | 104             |
| Grade 2                   | 77 (34.5)      | 146 (65.5)        | 223             |
| Grade 3                   | 50 (33.6)      | 99 (66.4)         | 149             |
| Grade 4                   | 17 (18.4)      | 71 (81.6)         | 88              |
| Axial length > 25.5 mm    | 27 (20.3)      | 106 (79.7)        | 133             |
| Diabetes mellitus         | 54 (39.1)      | 84 (60.9)         | 138             |

### Table 4: The multivariate logistic regression model depicting the relationship of variables to the presence of corticocapsular adhesions

| Variable                  | Log odds | Standard error | Wald statistic | Degrees of freedom | Level of significance | Odds  |
|---------------------------|----------|----------------|----------------|--------------------|-----------------------|-------|
| Age                       | 0.032    | 0.015          | 4.807          | 1                  | 0.028                 | 1.033 |
| Gender                    | 0.603    | 0.272          | 4.921          | 1                  | 0.027                 | 1.827 |
| Nuclear cataract          | −0.587   | 0.456          | 1.657          | 1                  | 0.198                 | 0.556 |
| Anterior cortical cataract| 2.350    | 0.365          | 41.359         | 1                  | 0.000                 | 10.489|
| Posterior cortical cataract| 1.459    | 0.326          | 20.063         | 1                  | 0.000                 | 4.301 |
| Posterior subcapsular cataract| 0.190   | 0.278          | 0.467          | 1                  | 0.494                 | 1.210 |
| Grade 2                   | 0.309    | 0.304          | 1.030          | 1                  | 0.310                 | 1.362 |
| Grade 3                   | 0.357    | 0.318          | 1.256          | 1                  | 0.262                 | 1.428 |
| Grade 4                   | −0.754   | 0.439          | 2.945          | 1                  | 0.086                 | 0.471 |
| Axial length              | −0.129   | 0.059          | 4.748          | 1                  | 0.029                 | 0.879 |
| Diabetes mellitus         | 0.042    | 0.302          | 0.019          | 1                  | 0.891                 | 1.042 |
| Constant                  | −3.100   | 1.186          | 2.436          | 1                  | 0.119                 | 0.045 |

*Versus other types, †Versus other grades, ‡Axial length > 25.5 mm versus axial length ≤ 25.5 mm, §Diabetics versus non-diabetics

### Table 5: Incidence of corticocapsular adhesions in eyes with and without cortical opacities in relation to age and gender

| Age            | Gender  | Corticalopacity present (n = 255 subjects) | No cortical opacity (n = 325 subjects) |
|----------------|---------|--------------------------------------------|---------------------------------------|
|                |         | CCA present (n = 167) No. (%) | No CCA (n = 88) No. (%) | CCA present (n = 22) No. (%) | No CCA (n = 303) No. (%) |
| <55 years (n = 149 subjects) | Males (n = 103) | 4 (3.9) 19 (18.4) | 5 (4.9) 75 (72.8) | 0 (0.0) 118 (54.8) | 0 (0.0) 221 (49.4) |
|                | Females (n = 46) | 7 (15.2) 9 (19.6) | 0 (0.0) 30 (65.2) | 8 (3.7) 80 (37) | 8 (3.7) 131 (61.7) |
| ≥55 years (n = 431 subjects) | Males (n = 215) | 50 (23.3) 38 (17.7) | 9 (4.2) 118 (54.8) | 0 (0.0) 221 (49.4) | 0 (0.0) 221 (49.4) |
|                | Females (n = 216) | 106 (49.1) 22 (10.2) | 8 (3.7) 80 (37) | 8 (3.7) 131 (61.7) | 8 (3.7) 131 (61.7) |

CCA - Corticocapsular adhesions
This could be because surgery to remove age-related cataracts is done at a relatively early stage. A number of epidemiological studies on risk factors associated with cataract development have been conducted. Although high blood pressure, age and diabetes mellitus have been enumerated to be associated with the development of cataract, their role in the genesis of CCA is largely unknown. In the present study, the incidence of CCA was found to be higher in elderly patients. It has been hypothesized that when mitotically active equatorial lens epithelial cells (LEC) proliferate and migrate either to the anterior or posterior region of the lens, the accumulation of secretory extracellular material results in the formation of CCA. The extracellular protein turnover is more in equatorial LECs compared to anterior LECs which could be the most likely place for the origin of CCA. We speculate that the presence of CCA could be attributed to the accumulation of secretory extracellular material due to advancing age.

In the present study the criterion for cases was based on intraoperative visualization of furry surface of cortex during epinucleus and cortex removal with or without preoperative presence of CCA on slit-lamp examination rather than on failure to achieve hydrodissection or rotation because the causes for the latter are multifactorial and the observations could be subjective [Fig. 4].

In the present study, presence of CCA was found to be greater in female subjects. A case-control studies that considered a number of potential cataractogenic risk factors has also reported that women are at an increased risk for cortical cataracts only. In a population-based prevalence survey in Beaver Dam, Wisconsin, women had more cortical opacities compared to men in similar age groups. The increased inclination to develop cortical cataracts in women could predispose to the development of CCA. We speculate that some hormonal influences may be responsible for the increased incidence of CCA in females. However, this association between the occurrence of CCA and the female gender requires further investigation and explanation.

In the present study, the occurrence of CCA was found to be higher in cortical cataracts and mixed cataracts while the association was negligible in isolated cataracts. The significantly increased association of developing CCA with cortical cataracts probably indicates the common etiological basis for CCA and cortical cataracts. This speculation on the impact of cortical cataract on CCA awaits verification and further investigations in a more controlled manner.

We did not find any association between grade of cataract and CCA and we attribute this to the inadequate sample size. Our clinical experience and observations suggest an increased association between CCA and dense cataracts. However, further work in this area is warranted before establishing a definitive association. In the present study, with axial length (AXL) < 25.5 mm the association of CCA declined by 12%. The association of CCA with nuclear cataract and PSC was minimal and we speculate the association of CCA to be low due to absence of cortical cataract development in high myopia. Cross-sectional data from the studies has provided evidence suggestive of an association between high myopia and both nuclear cataract and PSC but not cortical cataract. In the present series, the association between diabetes mellitus and CCA did not attain statistical significance. However, within the diabetic group, the presence of CCA was 90.3% in subjects with cortical cataracts.

Diabetes has been reported to be significantly associated with cortical cataracts, as well as with nuclear opacities. We believe that CCA could be closely associated with diabetes although this has not been statistically proven in our results. If we had recruited equal number of individuals with diabetes relative to the non-diabetic population, we probably could have achieved statistical significance. Our observation that diabetes has a common association for CCA, appears true since diabetes mellitus showed increased incidence of cortical cataract. We speculate that the mechanisms attributed to cataractogenesis in diabetes could be similar even for CCA formation.

The sample size of our controls was twice the size of our cases. This consolidates our results. To avoid false results due to improper or biased recall of facts by subjects, we did not evaluate other known associations causing cortical cataracts, such as history of estrogens used by women, sun exposure, smoking, which could also be possibly linked to the development of CCA.

Information on the associations with CCA enables the surgeon to especially examine the eye to detect CCA during preoperative assessment. While performing cataract surgery on eyes that were precluded from standardized slit-lamp examination of the lens, such as eyes with small pupil and eyes allergic to dilating drops, anticipating the possible presence of CCA can avoid overstressing the bag and zonules during rotation. Examination of eye for extent of CCA would allow the surgeon to perform focal cortical cleaving hydrodissection in the specific clock hours/ quadrants, to achieve adequate hydrodissection and successful rotation thereof. Focal hydrodissection in such eyes can prevent undesired consequences of a compromised zonular apparatus. When the aspiration of these adhesions is inadequate we could actually leave behind adherent mitotically active lens epithelial cells which have the potential to proliferate and migrate across the visual axis causing posterior capsule opacification.

The knowledge related to the associations of CCA could help further research in understanding the nature of CCA and the remedy, if at all, to overcome CCA. It would be interesting to identify specific associations that a patient might possess prior to cataract surgery that would identify CCA.

In conclusion, the association of CCA increases with cortical cataract, increased age and female gender.

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