Chapter 6

Study of Some Parameters in Sera of Individuals with Senile Cataract
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6.1 INTRODUCTION

It is generally agreed that apart from the cataractogenic factors associated with the lens, a number of systemic risk factors are associated with the development of age-related cataract. While a few, such as elevated levels of plasma glucose (Kahn et al., 1977) and diabetes (Harding et al., 1993), have long been known, significantly changed concentrations in a number of other plasma constituents have also been reported as associated with an increased relative risk of cataract.

The Edinburgh study of a wide range of such variables was reported in several publications (Bartholomew et al., 1980; Phillips et al., 1980; Clayton et al., 1980; Clayton et al., 1982; Clayton et al., 1984; Cuthbert et al., 1987). Some other reports were also available (Miglior et al., 1989; Mohan et al., 1989 and Italian-American Study Group, 1991). The Edinburgh based study group found significantly raised levels of some constituents namely bilirubin, creatinine, and glucose in blood in cataract patients compared with controls, and significantly lowered levels of some other constituents in blood (Clayton et al., 1980; Clayton et al., 1984). Schoenfeld et al (1993) reported that a high albumin/globulin ratio decreased the risk for mixed cataract formation. Donnelly et al. (1995) examined the albumin/(total protein-albumin) ratio, which approximates the albumin/globulin ratio associated with with cataract.

Studies carried out in Rhesus monkeys have revealed that ultrastructural membrane alterations preceded protein profile alterations and lens opacification (Farnsworth et al., 1980). They also observed that morphological
changes were evident in the pre-cataractous lens. Increased membrane permeability has been implicated in many experimental cataracts (Barber, 1973). The presence of serum antibodies to lens protein in over 80% of cataract patients by the gel precipitation test is a significant finding (Angunawela, 1987).

Clayton et al (1984) suggested that the differences in plasma constituents between patients and controls may differ for different age groups. According to them one should be strict regarding the age of the study group and the controls, as well while doing such a study. Donnelly et al. (1995) measured the levels of 18 plasma constituents in a population of 1000 matched case-control pairs. Ten of these and the albumin/ (total protein-albumin) ratio showed significant association with cataract.

In order to investigate the effects of the differences in some of the plasma constituents, we analyzed serum total phospholipids, cholesterol and proteins from fasting patients (50–68 years) with cataract. In this context fasting sera of patients (50–68 years) attending our hospital with any localized disease without cataract, diabetes, and other systemic or metabolic diseases were taken as control. The detailed methodology is described in the chapter of materials and methods (Chapter 2).

6.2 SERUM PARAMETERS

Our results of estimations of the contents of total phospholipids, cholesterol and proteins in sera of patients with different types of cataract are shown in Table 6.1 and Table 6.2. These values have been compared with sera of individuals without cataract but of the same age group, which are taken as controls (Table 6.1 and Table 6.2).
### Table 6.1

Some parameters in sera of individuals with senile cataract:

<table>
<thead>
<tr>
<th></th>
<th>Control (15)</th>
<th>Immature (15)</th>
<th>Mature (15)</th>
<th>Hypermature (15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total phospholipids</td>
<td>143.0±14.5</td>
<td>161.02±39.03</td>
<td>*178.44±26.61</td>
<td>140.27±27.82</td>
</tr>
<tr>
<td>(mean) mg per 100 ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cholesterol</td>
<td>190.0 ±25.06</td>
<td>*230.08 ±34.10</td>
<td>**223.90±26.08</td>
<td>*238.26±40.13</td>
</tr>
<tr>
<td>(mean) mg per 100 ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total proteins</td>
<td>8.98±0.48</td>
<td>*6.74±0.62</td>
<td>*7.02±0.91</td>
<td>*6.9±0.82</td>
</tr>
<tr>
<td>(mean) G per 100 ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figures in parenthesis indicate the number of experiments in each group. Figures with ± symbol indicate Standard Deviation. Age group: 50–68 years.

Control-Individuals without cataract, but of about the same age group as patients with cataract. The P-value is calculated by comparing the data to normal.

*P<0.01.  
**P<0.05

### Table 6.2

Serum total phospholipids and serum total cholesterol as related to serum total proteins in human senile cataract:

<table>
<thead>
<tr>
<th></th>
<th>Control (15)</th>
<th>Immature (15)</th>
<th>Mature (15)</th>
<th>Hypermature (15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of total phospho-</td>
<td>0.0146±0.002</td>
<td>*0.0244±0.0027</td>
<td>*0.0259±0.0031</td>
<td>0.0193±0.0023</td>
</tr>
<tr>
<td>lipids to total proteins</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio of total Cholesterol to total proteins</td>
<td>0.0231±0.004</td>
<td>0.0352±0.0031</td>
<td>*0.0309±0.0034</td>
<td>0.0348±0.0038</td>
</tr>
</tbody>
</table>

Figures given in parenthesis indicate the number of experiments in each group. Figures with ± symbol indicate Standard Deviation. Age group: 50–68 years.

Control – Individuals without cataract, but of about the same age group as patients with cataract. The P-value is calculated by comparing the data to normal.

*P<0.01
Fig. 6.1 Serum total phospholipids (mg per 100 ml) and total cholesterol (mg per 100 ml) in controls and patients with different stages of cataract. Values are the mean of 15 experiments in each group ±SD. phos, serum total phospholipids; chol, serum total cholesterol; Immat, immature; Mat, mature; H-mat, hypermature.

Fig. 6.2 Serum total proteins (G per 100 ml) in controls and patients with different stages of cataract. Values are the mean of 15 experiments in each group ±SD. Protein, Serum total proteins; Immat, immature; Mat, mature; H-mat, hypermature.
6.2.1 Total Serum Phospholipids

This investigation reveals that the content of total serum phospholipids is significantly increased (P < 0.01) in mature cataracts as compared to controls, while in the other two types of cataracts, there is no significant alteration (Table 6.1, Figure 6.1).

6.2.2 Total Serum Cholesterol

We observed that the content of serum total cholesterol at each stage of progression of cataract is higher as compared to the control (Table 6.1, Figure 6.1). This increase in the content of serum cholesterol in each stage of cataract is statistically significant.

6.2.3 Total Serum Proteins

The content of total proteins, as observed from our results, decreases in a statistically significant manner at each stage of maturation of cataract as compared to the normal control (Table 6.1, Figure 6.2). However, it should be noted that the range of normal serum protein content measured by our methodology is higher than the usual normal range quoted by Hawk (1965).

6.2.4 Ratio of Serum Phospholipids to Proteins

On calculating the ratio of serum total phospholipids to serum total proteins it is observed that this ratio is higher in sera of individuals with cataract at any stage of maturation as compared to the controls (Table 6.2, Figure 6.3). The increase in the ratio of total phospholipids to serum total proteins is significant in the
Fig. 6.3 The ratio of serum total phospholipids to serum total proteins in different stages of cataract (linear trendline). Values are the mean of 15 experiments in each group ±SD. In the horizontal axis: 1, control; 2, immature; 3, mature; 4, hypermature.

Fig. 6.4 The ratio of serum total cholesterol to serum total proteins in different stages of cataract (linear trendline). Values are the mean of 15 experiments in each group ±SD. In the horizontal axis: 1, control; 2, immature; 3, mature; 4, hypermature.
immature (P<0.01) and mature (P<0.01) stages of cataract, whereas the increase of
the ratio in the hypermature stage does not have any statistical significance.

6.2.5 Ratio of Serum Cholesterol to Proteins

The ratio of serum total cholesterol to serum total proteins is also
higher in sera of individuals with cataract at any stage of maturation as
compared to controls (Table 6.2, Figure 6.4). The increase in this ratio is
significant only in the mature stage (P<0.01) of cataract. In the other two
stages it does not have statistical significance.

6.3 DISCUSSION

We found that serum total phospholipids increase in individuals with
senile cataract. The increase is significant in patients with mature stage of cataract
(Table 6.1, Figure 6.1). This is in contrast to the consistent reduction in the
phospholipids of proteolipids in mature stage of cataractous lenses (Chapter 3). This
significant and constant observation needs to be further investigated before drawing
any conclusion.

We observed that the total protein in individuals without cataract is
8.98±0.48G per 100 ml (Table 6.1, Figure 6.2). These values seem higher than the
usual normal range as reported by Hawk (1965a, 1965b). In spite of reviewing
thoroughly the methodology used, we could not find any reason to explain this
discrepancy. This may, however, be accepted as a normal control for this study, as an
absolutely identical procedure was used for sera of individuals with cataract. Hence,
a statistically significant reduction of total proteins in sera of individuals at each
stage of maturation of cataract as compared with the control values is to be noted (Table 6.1, Figure 6.2).

Furthermore, the ratio of phospholipids to proteins in sera of cataractous individuals was higher than the controls (Table 6.2, Figure 6.3). This would suggest an alteration in the balance of these substances, which, if also can be shown in aqueous humour, may assume a great significance.

From our data of alterations in serum levels of phospholipids and proteins in cataractous individuals, it may be surmised that senile cataract has some correlation with the nutritional status of the individual. **This may be one of the factors responsible for the prevalence of senile cataract in the relatively younger age group in the third world countries.** Virgolici and Popescu (2006) showed that alterations in different blood constituents are risk factors for development of senile cataract. Studies by Delcourt et al. (2005) revealed that people having low plasma albumin have a higher risk of developing cataract and they suggested of an association of protein undernutrition with increased risk of cataract. Mirsamadi et al. (2003) analyzed blood biochemistry including serum levels protein, albumin in cataractous, and control patients and showed that these have a positive and significant correlation with cataract. Our study report is in agreement with all these previous studies. However, our result contradicts the results of Donnelly et al. (1995), who showed that increased total protein in blood has got non-specific cataractogenic effects. Therefore, it requires more studies of total serum protein with a different method in senile cataractous patients and proper controls in multiethnic population.

Our results demonstrated that the serum total cholesterol increases with the progression of cataract (Table 6.1, Figure 6.1). This, associated with the elevation of serum total phospholipids level, denotes that hyperlipidemia is a risk factor of
cataractogenesis. Though, few study reports are available related to the correlation between the status of serum total phospholipids and senile cataract, there are several study reports on the correlation of serum total cholesterol and senile cataract.

Ciccarelli et al. (2005) showed that elevated serum cholesterol in patients with long term liver transplantation (Recipients) may cause the development of cataract. Cataracts were observed from 8 weeks in untreated hypercholesterolemic rats and the incidence of cataract increased to 100% by 15 weeks (Yoshida et al., 2005). Shibata et al. (2003) demonstrated that the decreasing the serum cholesterol level of hypercholesterolemic rats can delay the development of lens opacities.

Mirsamadi and Nourmohammadi (2003) found that human age related cataract is associated with high serum cholesterol level. Meyer et al. (2003), Hiller et al. (2003), Lee et al. (2001), Goodrich et al. (1999) and Klein et al. (1997) also observed that high serum cholesterol level is related to senile cataract formation. Our result is in agreement with all these results. However, our result contradicts the observation of Donnelly et al. (1995), who reported that the cholesterol levels, in their study, were significantly lower in the cataract group than in the controls. They further suggested that the lower serum cholesterol might imply a defect in metabolism of cell membrane leading to cataractogenesis.

In contrast to the suggestions of Donnelly et al. (1995), who gave stress upon their finding of low serum total cholesterol in cataractous patients and their explanation to the associated cataract formation, it is seen that a major amount of the requirements of cholesterol in the lens for the formation of plasma membranes are met by self-synthesis only (Hockwin et al., 1991). So, the level of serum cholesterol may not have a direct effect on senile cataractogenesis.
The serum level of total cholesterol was found to increase in senile cataractous patients of our study whereas the serum total protein decreased (Table 6.1, Figure 6.1 and Figure 6.2). The term senile cataract means cataract due to ageing. Decrease of serum total proteins associated with ageing can be explained by protein oxidation by free radicals. But decrease of serum total cholesterol with age may be uncommon as cholesterol itself may act as an antioxidant (Girao et al., 1999), and therefore, it is refractory to oxidation by free radicals. Our result of increased serum total cholesterol and decreased serum total protein lead to the increase in cholesterol to protein ratio (Table 6.2 and Fig 6.4) with the progression of cataract.

6.4 CONCLUSION

This experiment revealed that there is an increase in serum total phospholipids and serum total cholesterol in cataractous individuals. These are coupled with a reduction in the serum total proteins in cataractous patients. These alterations in serum lead to a rising trend in the ratio of total phospholipids to total proteins and total cholesterol to total proteins. These alterations may be some of the factors responsible or associated with cataractogenesis in senile individuals. Cataract is a multifactorial disease. We do not insist on increased serum total phospholipids, increased serum total cholesterol and decreased total serum total protein level to be the conclusive alteration in the processes of senile cataract formation. Of course, it is possible that a gradual and constant variation in these parameters together with the phospholipids and protein changes in the senile lens maybe some of the predisposing factors in cataractogenesis.
6.5 REFERENCES


