Morphological and Morphometrical Study of Human Lens in Senile Cataract

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Abstract

Histological changes were studied in 34 senile cataractous lenses removed surgically from patients aged 50 to 78 years. Sixty-eight percent had nuclear sclerosis, 44% swollen cells and morgagnian globular changes, 23% calcium deposition, 15% migration of epithelial cells beneath posterior capsule and villous projection in posterior in 7%. Several cases had more than one histological abnormality. There was significant reduction in the diameter of epithelial cells of the cataract and insignificant change in capsular thickness (JPMA 47:141,1997).

Introduction

The lens is one of the components of ocular refractive media which transmit and refract light and is the only component whose refractive powercanbe varied. The normal lens is soft elastic and perfectly transparent due to uniform arrangement of cells in the axial portion of the lens, the consistent thickness of their cell membranes, the finely granular and evenly dense cytoplasm and the paucity of organelles. Cataract is an opacificationorloss of transparency in the crystalline lens of the eye. The senile cataract that constitutes a public health problem is the age related opacification of the lens that impairs vision to such an extent that occupational pursuits or the activities of daily living are severely restricted whichleads to economic and psychological deprivation that adversely affect the quality of life and occurs in persons above 50 years. Cataract is a major cause of blindness in the world being 400 times more in Asia than Europe[1]. The risk of occurrance of cataract in differentparts of the world, its causative factors, and biochemical aspects[2,3] have been studied thoroughly. This study reports the morphological and morphometric changes in the senile cataract.

Materials and Methods

Three hundred and fifty cases of senile cataract admitted in ophthalmological ward of Jinnah Postgraduate Medical Centre, Karachi for extraction during 1991 to 1994 were followed up for general and clinical examination. Fifty one patients undergoing intracapsular cataract extraction without histoiy of ocular trauma, glaucoma, use of corticosteroids and suffering from any systemic disease (e.g., diabetes mellitus, hypertension etc) were selected and cataracts from any other cause were excluded. Seven lenses being clinically normal were obtained with cooperation of Eye Bank Society of Pakistan from different eye centres of Karachi during 1991 to 1994 and 51 senile intracapsular cataractous lenses from Eye Theatre of Jinnah Postgraduate Medical centre, Karachi were processed immediately to avoid any morphological change due to tissue death. On histological examination, only 4 out of 7(ages 51,58,65 and 72 years) were absolutely normal and 34 out of 51(50 to 78 years) were intracapsular senile cataracts. Evety lens (nonnal orcataractous) was left forfixation in 10% buffered neutral formaline[4] for 24 hours then cut into two halves and fixed in fresh fixative for another 24 hours. The tissues were then dehydrated in ascending grades of alcohol from 70% to absolute alcohol. Tissues were cleaned in xylene and embedded in paraffm after paraffm infiltration. Three micron thick sections

stained with haemotoxylin and eosin, Masson's trichrome and PAS were examined for morphological and morphometrical changes in lens capsule, epithelium, fibers and nucleus.

Results

The control lenses showed almost normal appearance on gross examination. They were almost transparent, non-vascular, soft in consistency elastic in nature and bi-convex in shape being some what flatter anteriorly, surfaces were smooth with an average diameter of 9mm and thickness of 3-4 mm. The cataractous lenses were opaque yellow to brown in colour, hard in consistency and had uneven surfaces and diameters. Histologically the transverse sections of control lenses showed biconvex body enveloped by capsule with lens nucleus in the centre separated posteriorly from capsule by posterior capsule only, while anteriorly and at equators by subcapsular monolayered sheet of epithelial cells alongwith anterior cortex composed of parallel and mendionally arranged lamellae of lens cells or fibers whose nuclei defined the bent arrangement known as bow configuration (Figure 1).

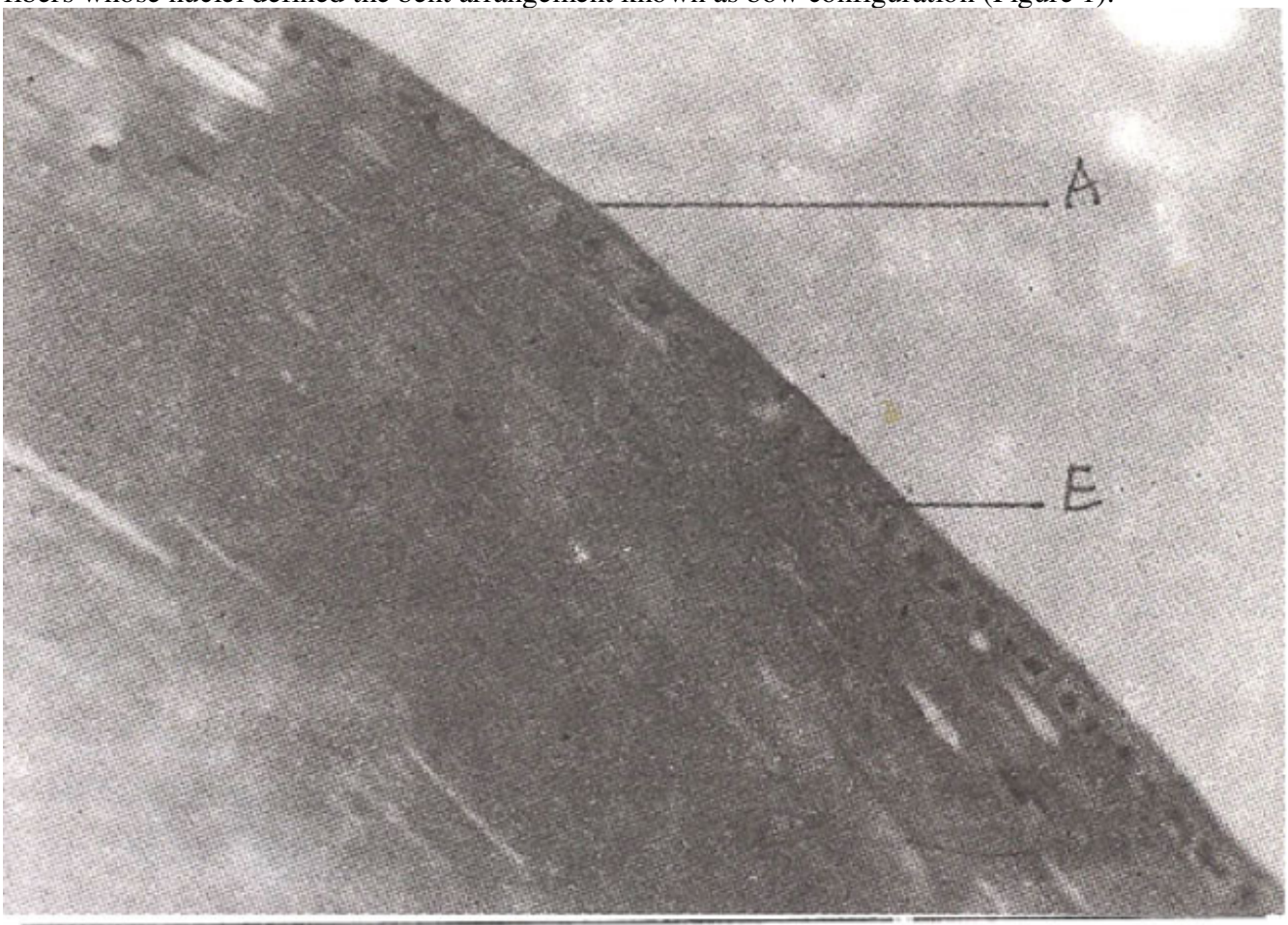

Figure 1. Photomicrograph of 3 µm thick paraffin section showing anterior part of normal human lens stained with H & E including the anterior cuboidal epithelium (E) and anterior lens capsule (A). The cellular nature of lens substance is prone to artifactural distortion during histological preparation. Oval nuclei of lens fibers in the anterior cortex of lens substance are visible. X 410.

The nucleus showed antero-posterior arrangement of primaiy lens fibers, surrounded meriodonally by secondaiy fibers.

A decrease in the thickness of the capsule in cataracts at all planes was recorded when compared with the normal lenses. The mean diameter of subcapsular single sheeted cuboidal epithelial cells (8.98±0.36 urn) was significantly reduced when compared with that of normal lenses (11.86±0.97 um)as shown in Table I.

Table I. Comparison between the thickness of the capsule (µm) and epithelial cell diameter (µm) in cataractous and normal lenses.

Parameters	Controls	Cataractous	Probability of difference from controls
Anterior capsule thickness	7.22±0.96	6.84±0.42	>0.05
Posterior capsule thickness	5.00±0.66	2.88±0.27	>0.05
Equatorial capsule thickness	5.69±0.57	4.70±0.36	>0.05
Epithelial cell diameter	11.86±0.97	8.98±0.24	<0.05

The data are presented as the mean±SEM.

Thecortexofcataractous lenses lost the normal lameller arrangement and the bow configuration and showed following degenerative changes (Table II).

Table II. Frequency (percentage) distribution of different histopathological changes in 34 human senile cataractous lenses.

Change	No. of cases	Percentage of occurrance of change	Age (years)	Mean age (years)
Swollen cell or bladder cell	15	44.1	50-65	62.0
Morgagnian globules	12	35.3	60-70	65.5
Migration of epithelial cells beneath posterior capsule	5	14.7	62-71	67.0
Nuclear sclerosis	23	67.6	65-78	70.0
Dystrophic calcification	8	23.5	65-75	69.0
Villous projection in posterior capsule	2	5.9	77-78	77.5

The cellular swelling (bladder cell change): The intracellular degenerative change was observed in the lens cortex in 15 cases of between 50 and 65 years of age. The swollen cell diameter ranged between 18 and 84 um(Figure 2).

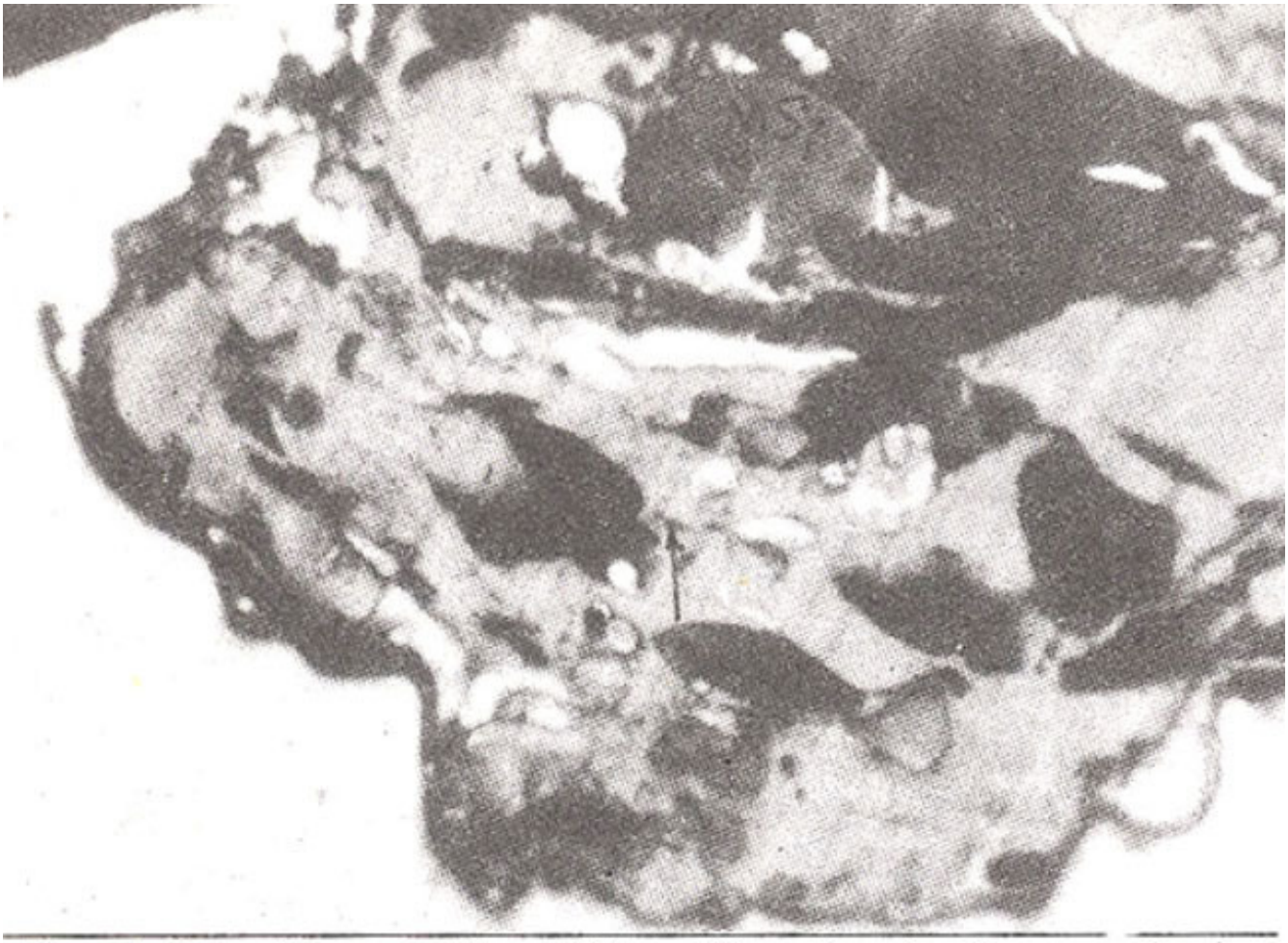

Figure 2. Photomicrograph of 3 µm thick paraffin section of senile cataract showing swollen cell (SW) and artrophic changes of pre-equatorial cortical fibers (arrow), stained with Masson's trichrome X 404.

The retention of broken lens cells debris and water in the form of tiny globules (morgagman globules) with diameterof 1.3 to 17 urn was noted in 12 cases of 60 to 70 years of age (Figure 3).

Figure 3. Photomicrograph of 3 µm thick paraffin section showing a globular collection of lens cell portions filling cleft (arrow) within the anterior cortex of lens substance of Morgagnian cataract stained with Masson's trichrome. X 205.

The epithelial cells showed migration beyond post-equatorial plane beneath the posterior capsule in 5 cases of 62 to 71 years of age and was accompanied by equatorial and posterior cortical degeneration (Figure 4).

Figure 4. Photomicrograph of 3 µm thick paraffin section showing posterior and equatorial part of cataractous lens stained with toludine blue (green filter used). The epithelium has proliferated posteriorly beyond the point (arrow) where it normally terminates in the nuclear bow. X 416.

Calcarious change (calcium deposition) was noted in 8 cases of 65 to 75 yeats age (Figure 5).

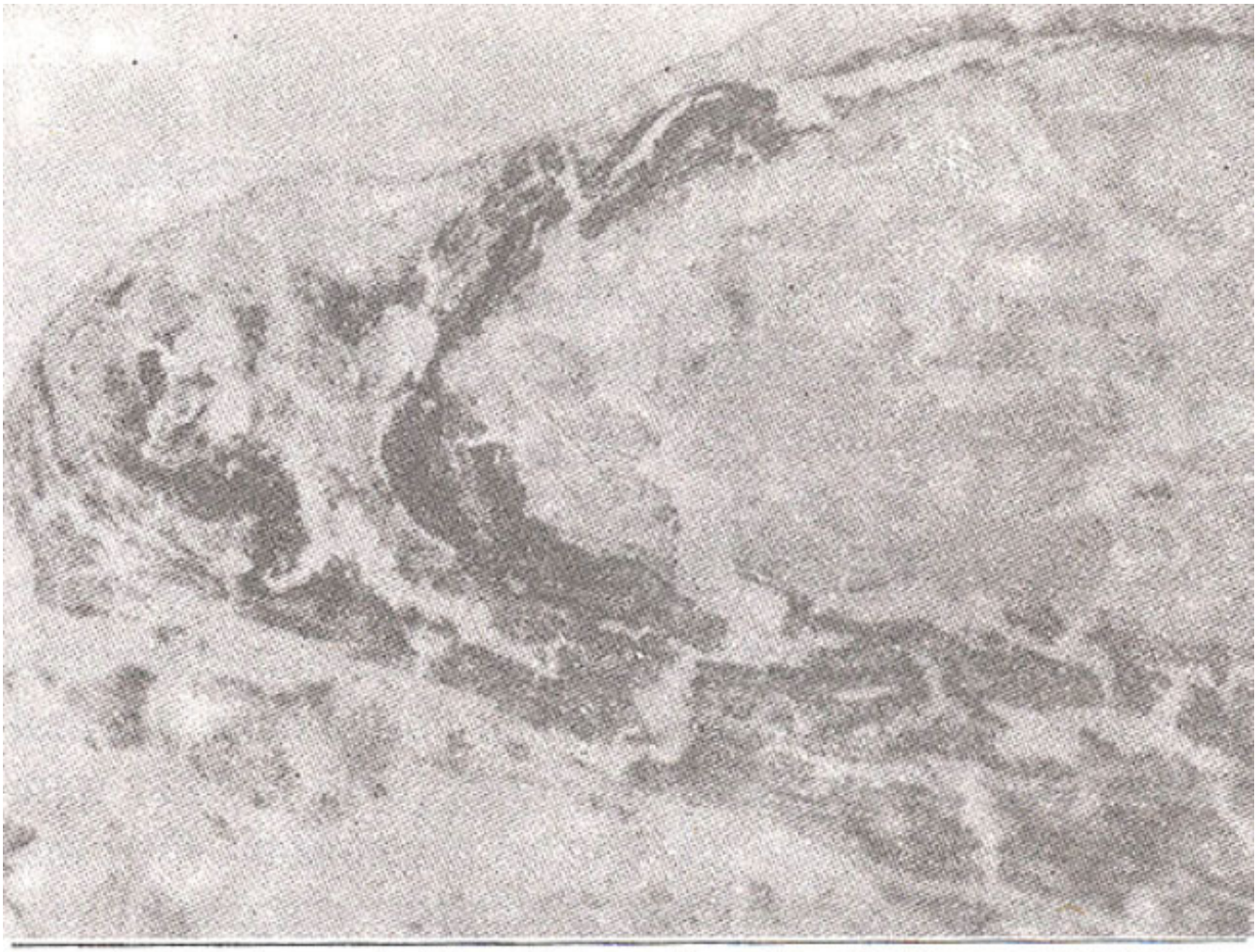

Figure 5. Photomicrograph of 3 µm thick paraffin section of calcareous cataract showing dystrophic calcium deposition (black stained areas) at corticonuclear junction stained with Von Kossa stain and counter stained with unclear fast red. X 404.

The nuclear lens cells (fibers) lost their usual regular concenteric laminations and whole mass took a uniform stain. This nuclear sclerotic change was observed in 23 cases of 65 to 78 yeats age (Figure 6).

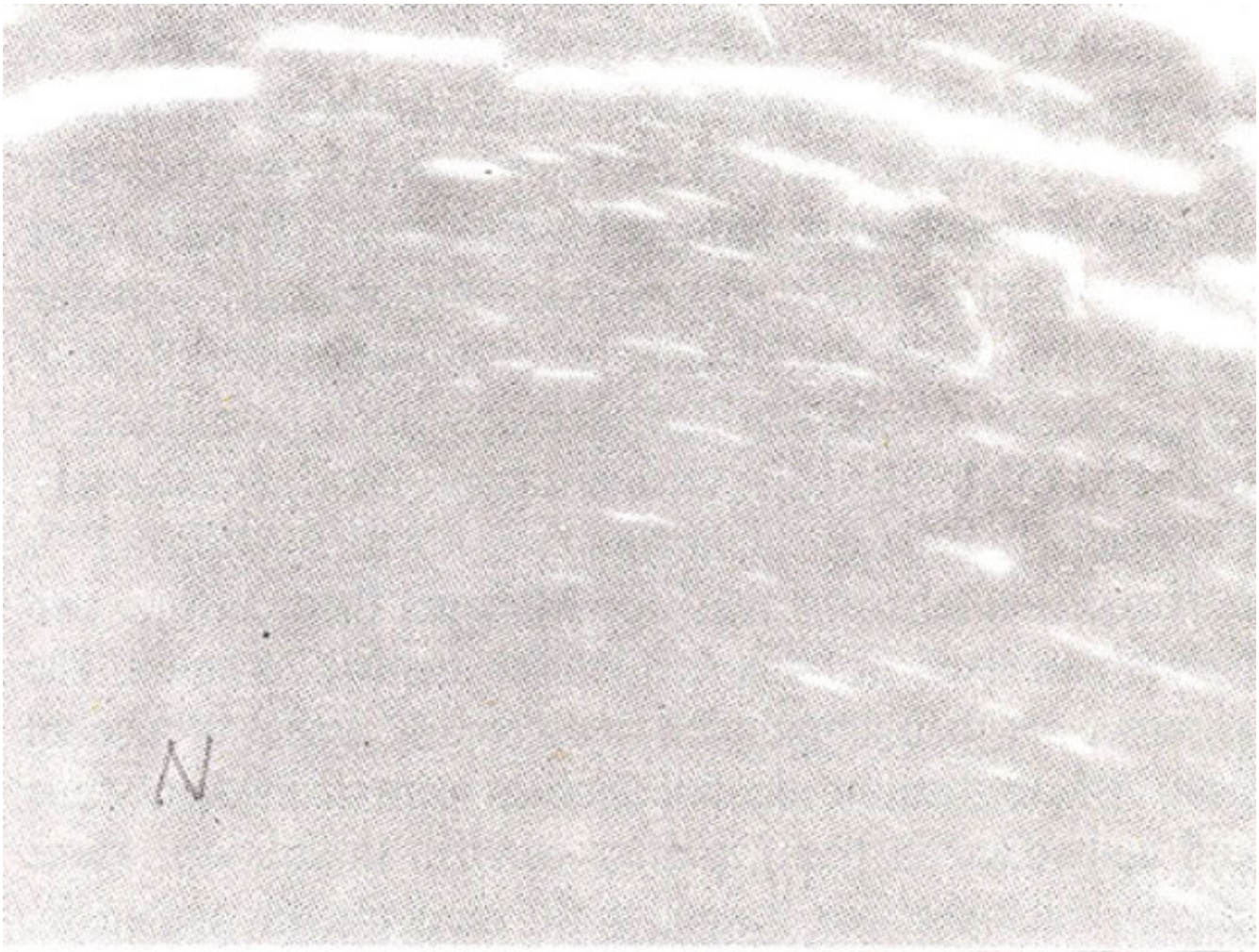

Figure 6. Photomicrograph of 3 µm thick paraffin section of nuclear cataract. Stained with Masson's trichrome showing loss of lammellar arrangement of nuclear fibers. Nucleus (N) showing homogenous mass X 400.

Villous projection of posterior processes of the lens fibers in posterior capsule was noted in two cases of 77 and 78 yeats.

Discussion

The significant decrease 8.98 j.tm±0.25 um was note in the mean epithelial cell diameter of the 34 cataractous lenses range 6 to 13 um when compared with the age matched control lenses where it was 11.86±1.37 um (range 10 to 14 um). This may be attributed to the decreased metabolic activity in cataractous lenses. Brown and Bron[6] measured the epithelial cell diameter 12.7 um (range 8 to 21 um) biomicroscopically of 100 subjects ranging between 11 to 75 years including 20 diabetics. Our fmdings onthe epithelial size do notcorrespond withtheir observations as they have included cases withawide range of age, normal and diseased from a different race. Bladdercell orswollen cell, a degenerative change might have resulted from decreased metabolic activity and the distuthed normal cell function in old age. Uga et al[7] observed similar change in 24 weeks old addy strain albino mice and suggested as an age related change. Similar changes were reported in Nakano Strain mice on 20th post-natal day[8] (hereditaiy cataract). These changes may be due to deficiency in the Na-K-ATPase leading to

electrolyte disturbances resulting in osmotio swelling. Galactose feeding also resulted in similar change[9].

Morgagnian Globular formation might have resulted by fragments of swollen cell wall. Gorthy[10] observed large globularbodies incataractous rat lens and postulated that these might have resulted from detachment of degraded massive fiber cell portions. Similar changes have been reported in a cataractous patient with retinitis pigmentosa[11] . Nuclear sclerosis recorded in maximum number of cases might have resulted from denaturation and coagulation of soluble lens protein. Same change occurred in the philly mouse lens (congenital cataract) due to the presence of abnormal lens proteins in attenuated lens[12]. Calcium deposition on the damaged lens fibers mightbe due to altered permeability ofthe lens resulted from decreased metabolism and energy because of old age. Lenticulardepositsofcalciumoxalate has also been observed by Johnson[13] who assumed that the calcium oxalate are fonnedin and by the lens probably as a result of altered biochemistry. Posterior migration of epithelial cells beneath posterior capsule might be stimulated.by prior equatorial and posterior cortical degeneration. Similar changes had been recorded in a hereditary cataract of philly mouse[12]. The reduced proliferative activity in the germinative zone might induce the posterior migration of epithelium. More than one changes were observed in many cataracts. Present study revealed that the decreased energy available for normal functioning of lens in old age resulted in degenerative and sclerotic changes.

Acknowledgements

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