A-4(3) International cooperative studies on the relationship between cataract appearance and UVR exposure

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Abstract

Cataract figures may differ among races and environmental conditions, including climate, but only a few studies with a reliable approach have been made to confirm these differences. Since the early 1990s, the influence of solar UV rays on human eye diseases, cataract in particular, has become a global concern. In order to clarify this scenario of UV-induced cataract formation in human eyes, further experimental and epidemiological studies have been required. Based on the above concept, epidemiological cataract studies have been carried out in two places in Japan (Noto and Amami) and three places overseas (the cities of Reykjavik, Iceland, Singapore, and Melbourne, Australia, for a preliminary survey). The methodology applied in each survey was the same as that of the Noto study. The examiners were the same throughout each survey. Among the items examined, a decrease of physiological lens transparency with ageing, prevalence of cataract including whole types, pterygium and the preventative effect of wearing sunglasses against pterygium formation are discussed in this report. Although the decrease of lens transparency with ageing was different in each group, there were similarities between the Icelanders and Japanese, and Noto, Amami and Singapore, respectively. There were however, clear differences between the former two and latter two groups in the subject, in their 60s and 70s. The clinical definition of cataract generally includes cortical, nuclear and subcapsular lens opacification, even though their formation mechanisms are not the same. The comparison of cataract prevalence (including whole types) with rather progressed stages among the Noto, Singapore and Reykjavik groups showed a significant relationship with the irradiation dose of solar UV-B. Cataract progression seemed to appear in the Noto subjects about 10 years earlier than in the Reykjavik subjects and 10 to 15 years later than in the Singapore subjects. Among the three types of lens opacification, cortical was most frequently seen. The prevalence of cortical cataract was significantly lower in the Reykjavik subjects than in Noto, Amami and Singapore. In addition, the prevalence of nuclear cataract was significantly higher in Amami and Singapore than in Noto and Reykjavik. From this study, the authors would like to consider that the scenario of UV-induced cataract is acceptable at least for the cortical type of cataract. The prevalence of pterygium in Noto, Amami, Singapore and Reykjavik was 6.4 %, 25.4%, 11.2% and 0.2%, respectively. The preventative effect of wearing sunglasses against pterygium formation was noticed in the subjects of Singapore by a case and control study.

Key Words cataract, UV-B, risk factors, Iceland, Singapore, Noto Japan, epidemiological survey

1. Introduction

Cataract is ranked as the most prevalent ocular disease in the aged people of both developing and industrialized countries. Recent increases in medicare fees for cataract treatment has brought serious problems to the total medicare systems of industrialized countries. In developing countries the primary cause of blindness is shifting from ocular infectious diseases to cataract. According to a WHO survey, 16 million people are estimated to have become blind because of cataract[1]. Among several risk factors for cataract formation, ultraviolet rays (UV), UV-B in particular, has been a focus recently. Since there have been few studies on relationship between the recent depletion of the ozone layer caused by environmental pollution and cataract induced by the increase of UV irradiation dose, this study was designed to clarify the relationship in racially and climatically different countries.

2. Survey places and subjects

The towns of Monzen (Noto area in Ishikawa Prefecture) and Kikaishima (Amami area in Kagoshima Prefecture) were the survey places in Japan. There were 615 participants in the Noto survey who were over 50 years old and had lived in the town for a long time. In the Amami group, there were 339 subjects over 40 years of age.

The survey places overseas were the cities of Reykjavik, Iceland, Singapore and Melbourne, Australia (preliminary survey). At present, the participants in the Reykjavik and Singapore surveys numbered 1,045 and 517 over 50 years of age, respectively.

	Noto	Amami	Iceland	Singapore	Australia
Latitude	37° 23'(N)	28° 19'	64° 04'	01° 22'(N)	37° 49'(S)
Longitude	136° 54'	130° 00'	21° 54'	103° 55'	144° 58'(E)
Average temperature	13.0℃	21.3℃	4.4℃	26.7℃	15.5℃
Average humidity	82%	74%	82%	84%	65%
Rainfall amount	805mm/year	2,870mm/year	798.1mm/year	2,171.5mm/year	638.7mm/year
UV-B radiation	122.9kj/m²	186.8kj/m²	40.3kj/m²	315.0kj/m²	135.7kj/m²

Table 1. Climatical conditions of the survey places

3. Gathering participants and examination

Subjects in the Reykjavik and Noto studies were randomly selected. In the Amami and Singapore surveys, the aim of the study and the contents of the ocular examination were announced to citizens through governmental information, newspapers and TV.

Ophthalmological examinations (Visual acuity test, Measurement of intra-ocular pressure, Slit lamp examination under non-dilated and dilated pupil, Documentation of the anterior eye segment[2], Fundus examination under dilated pupil, Fundus photography), changes of the lens by Scheimpflug and

retroillumination photography, and 25 item questionnaire [3] was completed.

Slit lamp examination was performed by the same experienced ophthalmologist throughout the entire survey. The objective diagnosis of cataract classification and grading was performed principally through photographed images. Cases without clear images of the lens were judged by the same fixed ophthalmologist based on findings obtained from slit-lamp observation. The cataract classification system applied in the studies followed the Japanese Cooperative Cataract Epidemiology Study Group System [4]. Since the grading classification of nuclear opacification used the Kanazawa Medical University System [5] which consists of grades I to IV, grades III and IV were unified as grade III to avoid confusion with the Japanese system.

Data analysis : Two types of analysis, by case and by eye, were performed. In the analysis by case, the pure type of opacification (cortical, nuclear and subcapsular) or the mixed type in one eye was used as the representative opacification form for that case. In the analysis by eye, the opacification types existing in the lens were chosen. The data analysis applied the T-test, 2test, and Mantel-Haenszel test.

4. Results

Among the data obtained from each survey place except Melbourne, the prevalence of lens transparency, lens opacification by case which included whole types, prevalence of opacification by type, characteristics of lens opacification figures and prevalence of pterygium and the preventative effect of sunglasses against pterygium formation are shown.

4.1 Noto study

A decrease in lens transparency was noticed with ageing. The ratio of cases with bilateral transparency was 60.4% of all cases in their 50s, and 35.7% and 14.4% in their 60s and 70s, respectively. The prevalence of opacified lenses, including whole grades and opacification types were 39.6% in subjects in their 50s and 64.3 % and 85.6% in their 60s and 70s, respectively. Those cases with over grade II were 5.3%, 23.5% and 56.8%. Cortical type cataracts were seen in 93.2% of the eyes of subjects in their 50s and 69.1 % and 86.6% in their 60s and 70s, respectively. Those with nuclear and subcapsular cataracts were 5.4% and 16.6%, 45.4% and 4.1%, 4.0% and 0.8%, respectively. The cortical type cataracts were seen in 93.2 % of the total examined eyes. Those of nuclear and subcapsular cataracts were 24.1 % and 3.0%, respectively. The prevalence of pterygium was 6.8 %.

4.2 Amami study

A decrease of lens transparency was noticed with ageing. The ratio of cases with bilateral transparency was 68.0% in subjects in their 40s, 46.0%, 16.9%, 3.1% and 0% in their 50s, 60s, 70s and over 80 years, respectively. The prevalence of opacified lenses including whole grades and opacification types were 32.0% in subjects in their 40s and 54.0%, 83.1%, 96.9 %, and 100 % in their 50s, 60s, 70s and over 80, respectively. Those cases with over grade II were 4.0 %, 12.7 %, 26.2 %, 60.0 % and 83.3 %, respectively. The cortical type was seen in 96.1% of the total examined eyes and nuclear and subcapsular types were seen in 48.5% and 14.7 %, respectively. The prevalence of pterygium was 25.4 %. There was no difference with gender and no significant correlation was noticed between cataract appearance and pterygium.

4.3 Icelandic study

Lens transparency decrease was noticed with ageing. The ratio of cases with bilateral transparency was 57.3% in subjects in their 50s, 39.0%, 14.7% and 0% in their 60s, 70s and over 80 years, respectively. The prevalence of opacified lenses including whole grades and opacification types were 42.7% in subjects in their 50s and 61.6%, 85.3% and 100 % in their 60s 70s and over 80, respectively. Those

cases over grade II were 2.2%, 10.5 %, 35.9 % and 62.3 %, respectively. The cortical type was seen in 92.2% of the total examined eyes and the nuclear and subcapsular types were seen in 25.6% and 4.1%, respectively. Among the types of cortical opacification, 6.6% were granular, a type which is seen less frequently in Japanese. The prevalence of pterygium was 0.2 %.

4.4 Singapore study

The ratio of cases with bilateral transparency was 47.3% in subjects in their 50s, 11.7%, 1.9 % and 0% in their 60s, 70s and over 80 years, respectively. No gender difference was noticed in any age group. The prevalence of opacified lenses including whole grades and opacification types were 52.7% in subjects of their 50s and 61.6%, 98.1% and 100 % in their 60s, 70s and over 80, respectively. Over grade· was seen in 16.1 %, 51.9 %, 78.8 % and 100 % of the subjects, respectively. The prevalence of cortical, nuclear and subcapsular opacification were 78.6%, 68.4% and 19.7 %, respectively. The prevalence of pterygium was 11.2 %.

4.5 Australian preliminary study

Since the study is ongoing, a comparison among the lens transparency prevalence of the Noto, Singapore and Icelandic subject groups and a part of the subjects of the Australian study was performed. The relationship between age and decreasing lens transparency was evaluated in the three age-matched subject groups using light scattering intensity at the anterior cortical region as an indicator. The most transparent subject group at 55 - 64 years was the Australian group. No significant difference in lens transparency changes was noticed between Noto and Icelandic groups. And, no difference in the above was observed in the subjects over 65 in all three groups.

4.6 A study on sunglasses as a defense tool against solar UV-B exposure to the eyes

Wearing sunglasses as a defense tool against pterygium formation was evaluated in a case and control study of the Singapore group (Table 2). The epidemiological data from this group showed that sunglasses have protective effect against pterygium formation.

[Hat]	30 - 40yrs	50yrs -
always/sometimes	1.0	1.0
never	1.02 (0.44 - 2.19)	1.52 (0.69 - 3.33)
[Eyeglasses]		
always/sometimes	1.0	1.0
never	1.95 (0.96 - 3.97) *	2.24 (1.15 - 4.38) **
[Sunglasses]		
always/sometimes	1.0	1.0
never	2.51 (1.03 - 6.16) **	2.52 (1.03 - 6.19) **

* $0.05 < p < 0.1$, ** $p < 0.05$

Table 2 UV protection and prevalence of pterygium (Singapore)

5. Discussion

Until this study, there have been no comparative cataract epidemiological studies by the same study group applying the same methodology in climatically and racially different places in Japan and overseas. The solar UV irradiation dose in Noto is about three times that of Reykjavik and those of Singapore and Melbourne are about five and 7 - 8 times that of Reykjavik, respectively. From this standpoint, the survey places in the study were of epidemiological value in investigating the influence of solar UV radiation to human eyes. Among several theories about human cataract formation, that of UV -induced cataract is a current focus worldwide. Since an experimental animal model has already been established in the lens research field, no one may deny the experimental proof of UV - induced cataract. However at present the UV scenario of human cataract has still not been clearly proved epidemiologically.

Although there were some differences in the tendency of physiological decrease of lens transparency with ageing, the significant differences were noticed between the subject groups in their 60s and 70s of Noto and Iceland and those of Amami and Singapore. Some risk factors related with ageing of the lens may exist between the Noto and Reykjavik subjects and the Amami and Singapore subjects, respectively (Fig.1). Chronic exposure to solar UV irradiation may be one of these factors.

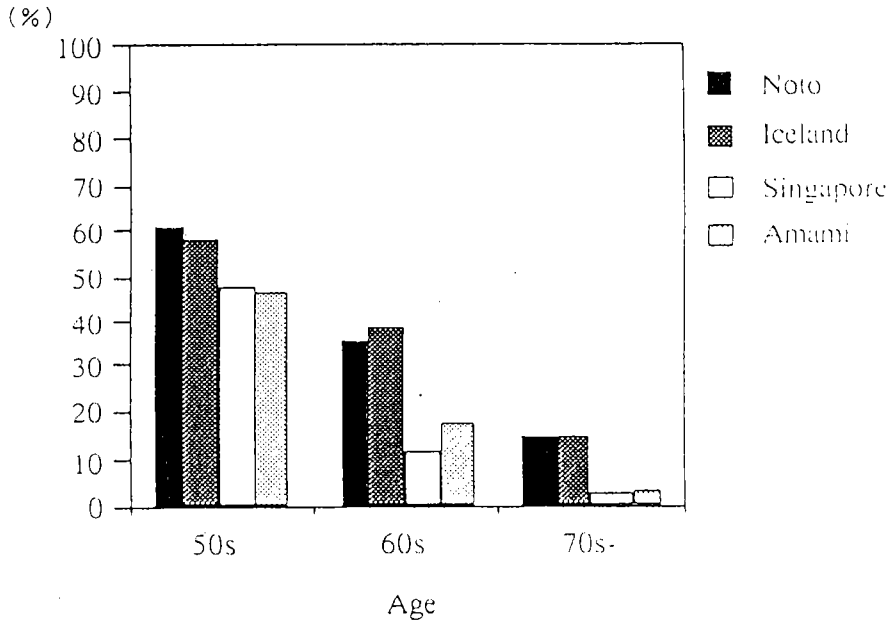

Figure 1 Prevalence of subjects with bilateral transparent lens

As shown in Fig.2, the prevalence of cataract, including whole opacity types, showed a close relationship with the UV irradiation dose in the survey place. A comparison of the prevalence of rather progressed cases of grades II and III in the Noto, Singapore and Iceland groups also showed interesting findings. At present, the authors may say that cataract progression was 10 years faster in the Noto group than in the Icelandic group and that of Singapore may be 10-15 years faster than that of the Japanese group (Fig.2). Although this finding is quite attractive for the study of epidemiology, the authors still do not have sufficient proof for all types of cataract.

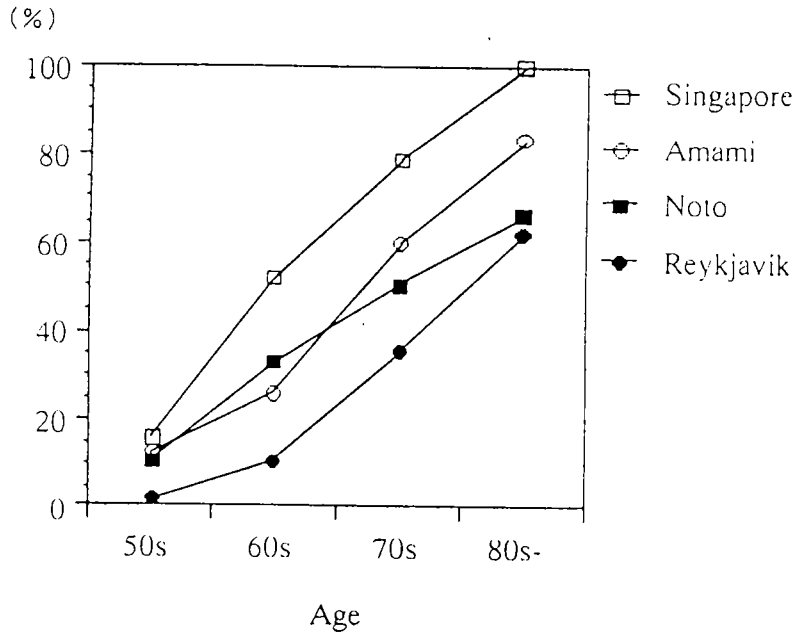

Figure 2 Prevalence of lens opacification over grade II

At present, the authors would like to consider that the UV scenario for cataract formation risk is acceptable for cortical type alone.

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