Diagnostic X-ray Exposure and Lens Opacities: The Beaver Dam Eye Study

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ABSTRACT

The Beaver Dam Eye Study is a population-based study of common age-related eye diseases. During the standardized medical history, the 4926 subjects were asked whether they had ever had a chest x-ray, computerized axial tomography (CAT) scan of the head, other x-rays of the head, x-rays of the abdomen, or other diagnostic x-rays. The eye examination included photographs of the lenses of the eyes, which were subsequently graded according to protocol. Nuclear sclerosis and posterior subcapsular opacity were significantly associated with CAT scans. If these relationships are causal, it would highlight the importance of minimizing such exposure to the lens of the eye. (*Am J Public Health.* 1993;83:588–590)

Introduction

The effects of radiation on living organisms are varied and depend on dosage as well as species'[1,2] and tissue-specific sensitivities.[3] With regard to the eye, most ultraviolet radiation is absorbed by the cornea and conjunctiva. However, ionizing radiation, because of its better penetration power, can reach all parts of the eye. The lens seems to be peculiarly sensitive because of effects on the lens epithelium.

Cataracts have been diagnosed in workers who have been routinely exposed to radiation[4] and in atomic bomb survivors.[4,5] Patients receiving therapeutic radiation have developed cataracts as well as radiation retinopathy and optic nerve damage.[2]

There have been few reports of the effects of diagnostic x-ray exposure on the lens, although Storrs and Byrd have suggested that repeated exposure to computerized axial tomography (CAT) scans of the head delivers a dose of radiation to the lens that may have cataractogenic potential.[6] Therefore, in the Beaver Dam Eye Study, we explored the potential relationship between exposure to diagnostic x-rays and lens opacities.

Methods

A private census of Beaver Dam, Wisc, was performed; the census procedures have been published elsewhere.[7] In brief, 4926 adults who were 43 to 84 years of age at the time of the census participated in the study. Informed consent was obtained for each subject.[8] As part of the standardized medical history, subjects were questioned as to whether they had ever had head, chest, abdominal, or other x-rays or CAT scans of the head.

The pupils were dilated with one drop each of 1% tropicamide and 2.5% phenylephrine. When the pupils were dilated photographs were taken with a Topcon SD Photo Slit lamp with the illuminating beam at 45° to the viewing system and specially designed fixation targets for each eye.[9] Ektachrome 200 ASA film was used. These photographs were subsequently graded for severity of nuclear sclerosis by comparing them with standard photographs according to protocol. The protocol describes five levels of severity of nuclear sclerosis; higher levels indicate more severe involvement. For this report, severity levels of 4 and 5 are grouped and are referred to as nuclear sclerotic opacity. The severity of cortical and posterior subcapsular opacities was determined from gradings of photographs taken through a dilated pupil with a Neitz camera that was specially modified for this study. The photographs that resulted were retroilluminated images of the lenses.[9] Any cortical opacity is considered to be positive for this lesion. Posterior subcapsular cataract involving more than 5% of the lens area is considered to be positive for this lesion.

Graders were masked to subject characteristics. Eyes for a subject were separated and graded independently from each other. Quality control procedures were employed to minimize variability and "drift" in grading.[10]

The quality control procedures involved two schemes. For estimates of variability, a set of 80 eyes that represented the kinds and severities of the lens opacities was periodically introduced in random sequence with the eyes to be graded. Gradings of these photographs were compared between graders and for each grader against his or her own previous gradings. In addition, another sample of slides was circulated among the graders and the resultant data were used for feedback. Periodically, the senior investigator (B.E.K.K.) graded photographs, and these data were shared with the graders.

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Estimates of comparability for the gradings differ for the grading schemes, but are high for all.[10]

The Statistical Analysis System (SAS) was used to analyze the data.[11] Multiple and polychotomous logistic regression analyses were used to calculate relative odds after adjusting for confounders of age and sex.[11] Confidence intervals for the relative odds were calculated.

Results

Table 1 describes the reported frequencies of responses concerning the various x-ray exposures. Chest x-ray was the most common (94.1%) and CAT scan of the head was the least common (16.9%) of the reported exposures. As has been elaborated in a previous report, the severity of nuclear sclerosis, cortical opacities, and posterior subcapsular cataracts increased with increasing age.[12] Women were more likely than men to be affected by nuclear sclerosis and cortical opacities. Therefore, in the analyses shown in Table 2, we adjusted for both age and sex. History of CAT scan added significant information in explaining the presence of cortical and posterior subcapsular lens opacities. None of the other kinds of x-ray exposure were significantly associated with the presence of lens opacities.

TABLE 1—Frequency of History of Diagnostic X-ray Exposure

History of X-ray Exposure	Chest		Abdomen		Head		CAT[a]		Other	
	No.	%	No.	%	No.	%	No.	%	No.	%
No[b]	234	4.8	1641	33.3	3134	63.6	3989	81.0	2131	43.3
Yes	4633	94.1	3182	64.6	1672	33.9	834	16.9	2696	54.7
Questionable	59	1.2	103	2.1	120	2.4	103	2.1	99	2.0

[a]Computerized axial tomography.
[b]Includes those for whom the data is missing.

TABLE 2—Age- and Sex-Adjusted Odds Ratios for Lens Opacities

X-ray Type	Posterior Subcapsular Opacity		Nuclear Sclerotic Opacity		Cortical Opacity	
	OR	95% CI	OR	95% CI	OR	95% CI
Abdomen	1.18	0.89, 1.55	1.04	0.85, 1.28	1.04	0.84, 1.29
Chest	1.74	0.74, 4.07	1.36	0.77, 2.42	1.16	0.62, 2.16
Head	1.27	0.98, 1.66	1.13	0.93, 1.38	0.87	0.71, 1.07
CAT scan	1.45	1.08, 1.95	1.28	1.02, 1.61	1.17	0.88, 1.55
Other	1.20	0.93, 1.55	0.98	0.81, 1.19	0.94	0.76, 1.15

Note. Odds ratios (ORs) are from multiple logistic regression with age and sex included in the models. CI = confidence interval; CAT = computerized axial tomography.

Discussion

Information concerning radiation injury as a consequence of diagnostic studies is limited. In a small study, Storrs and Byrd estimated that lens exposure from a CAT scan of the head varied from .47R to 6.29R, with a mean value of 4.2R. Because some patients have more than one scan, the same authors found the mean exposure in their group of patients to be 37.75R.[6] These patients had neurological problems and it is likely that they represent extreme exposures. Most persons in Beaver Dam who reported having had CAT scans had only one recorded in their medical charts (charts of a sample were reviewed by B.E.K.K.). However, one episode may actually require two scans (and therefore two times the dose) if an enhancing dye is used. Also, if there are technical difficulties, a repeat scan may be done. The lens opacity that has been reported to be most common in atomic bomb survivors is posterior subcapsular opacity.[4] Descriptions of the morphology of those opacities were not pathognomonic. The opacities reported on here are those changes that are commonly found in adult populations with no obvious radiation exposure experience. However, an increase in prevalence related to diagnostic x-ray exposure is a reasonable consideration.

Despite individual physicians' variations in charting habits, in only 1 of 20 charts that the author reviewed could a report of a CAT scan not be confirmed. Because subjects may have had their scans performed in another community, even the single individual may not have erred in his report.

The question of "confounding by indication" is a possibility in this study. For example, eye trauma has been thought to predispose to subsequent cataract formation and may also be the reason for a CAT scan. We did not find such an association. In an older population such as we studied, CAT scans may be ordered for neurologic conditions, especially strokes or transient ischemic attacks. It is possible that relative ischemia to the eye could be responsible for lens opacity and also for CAT scanning. We found no consistent relationship between history of stroke and presence of lens opacities.

These data were obtained during a prevalence study of eye disease; therefore, the antecedent–consequent nature of the relationship of lens opacities and CAT scans cannot be assessed. Prospective data would permit evaluation of the longitudinal nature of the relationship.

At this time, when CAT scans are relatively easy to obtain, the population's exposure to them may be increasing.[13] Although there are usually serious indications for ordering this test, if CAT scans are associated with severity of cataracts, then minimizing exposure by careful patient selection and development of shields or masks to protect the eye while not impairing the diagnostic utility of the scan could potentially diminish the threat of loss of sight due to age-related lens opacities. □

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Cardiovascular Disease Risk Factors: Improvements in Knowledge and Behavior in the 1980s

ABSTRACT

This study surveyed 4158 adults residing in two control cities of the Stanford Five-City Project. Analysis of five cross-sectional surveys (conducted in 1979 through 1990) demonstrated improvements in respondents' general cardiovascular disease risk factor knowledge and behaviors. Cholesterol-related knowledge and behavior showed particularly marked improvements. (*Am J Public Health.* 1993:83:590–593)

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Introduction

Americans received tremendous amounts of education in the 1980s about cardiovascular disease, the leading cause of death in American men and women. A multitude of media and public health organizations provided information on the effects of smoking, diet, and sedentary life-styles, and cholesterol-related risk was the major new cardiovascular disease focus. There have been separate cross-sectional, population-based surveys of general cardiovascular disease risk factor knowledge[1–4] and serial surveys demonstrating improvements in cholesterol-related knowledge and behaviors in the 1980s.[4–8] However, few published data have serially tracked changes in knowledge or behaviors related to general cardiovascular disease risk factors throughout the entire 1980s. Given the substantial resources expended on improving these parameters, and the potentially large public health impact of positive trends, it is important to document changes; we examine such changes using data from two control cities of the Stanford Five-City Project, a long-term study that used communitywide programs to reduce cardiovascular disease risk in intervention cities.[9–12]

Methods

This study examined two Five City Project control cities: Modesto (population 161 600), a northern California city with a mixed Hispanic and Anglo population and an agriculturally based economy, and San Luis Obispo (population 35 900), a predominantly Anglo, coastal California city with a technical college. Data were derived from five independent cross-sectional surveys (including all persons aged 25 to 74 residing in randomly selected households) conducted biennially for 10 years (1979 through 1980, 1981 through 1982, 1983 through 1984, 1985 through 1986, and 1989 through 1990). The design[9] and results[10–13] of the Stanford Five City Project have been reported previously.

Study participants were invited to visit the Five City Project clinic located in their community; there, trained interviewers asked them the questions analyzed in

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