Glaucoma and Health-Related Traffic Accidents: Evidence and Preventive Measures

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This review addresses the prevalence of glaucoma in Japan, where it affects around 5% for those aged 40 years and over, a large proportion of whom are not aware of their disorder and thus remain untreated. Glaucoma is one of the known causes of “health-related traffic accidents,” and it is important to screen drivers with possible glaucoma who are not aware of their visual field abnormalities. We propose that CLOCK CHART® be employed as a tool that even non-ophthalmologists could use to screen the visual fields of drivers, leading to possible diagnosis and treatment of glaucoma. This will promote safe driving.

Key words: public health, glaucoma, accidents, traffic, prevention & control, sleep apnea syndromes

Introduction

Recently, it has been shown that traffic accidents are in part caused by health issues. We have advocated a concept of “health-related traffic accidents,” which are defined as traffic accidents associated with some disorders such as glaucoma, neurological disorders, cardiovascular disorders, hypoglycemia, hearing loss, adverse effects linked to treatment, sleepiness linked to allergic disorders and sleep-related breathing disorders (SRBD) and so on1,2 (Table 1).

We, herein, describe health-related traffic accidents by focusing on glaucoma, and furthermore, we propose screening using CLOCK CHART®, which is a handy and reliable visual field screening tool that general physicians can apply for non-ophthalmologic patients.

Glaucoma and traffic accidents

Glaucoma is a disease characterized by the loss of retinal ganglion cells, which leads to visual field defects and blindness3, and a leading cause of visual impairment in Japan4. Diagnosis is based on examination of the optic nerve head and retinal nerve fiber layer by ophthalmoscopy or by imaging technique5. Visual field testing and intraocular pressure measurement are also necessary for diagnosis. Treatment options for open-angle glaucoma include pharmaceutical therapy, laser therapy, and surgery which aim to lower intraocular pressure3.

Reportedly, an estimated number of 4.6 million...
people in Japan suffer from glaucoma, and 90% of them are not aware of their condition. Glaucoma affects one in 20 people aged 40 years and over in Japan. The number of patients is thought to increase in this aging society. Previous studies showed that most glaucoma patients were usually unable to detect their own visual field defects until the changes had reached an advanced stage. Glaucomatous visual field defects have been associated with motor vehicle accidents previously. A previous study reported that traffic accidents were 1.65-fold more frequent in drivers with glaucoma. McGwin demonstrated that patients with moderate or severe visual field defects with glaucoma in the worse eye incur a higher risk of traffic accidents than those with no visual field defect. Elsewhere he reported that drivers with glaucoma whose visual fields were impaired as defined by pattern deviation were involved in at-fault traffic accidents twice the frequency of those not severely impaired. Various reports examined the parts of drivers' visual fields in which defects are significantly related to traffic accidents. In addition, drivers with glaucoma had greater impairment in their observation ability, lane positioning and planning approach, and their errors were more common at intersections, both traffic light-controlled and right-of-way-controlled. Older drivers with glaucoma had delayed hazard response times and first fixation on hazards, and therefore they need to improve their rapid eye movements to detect hazards effectively, leading to significant changes in the pattern of eye movements in patients with glaucoma. Screening is important considering the occurrence of serious traffic accidents.

**Glaucoma and SRBD**

Glaucoma share some common characteristics with SRBD, which is also attracting attention as a cause of traffic accidents. Glaucoma impair night-time sleep quality and quantity, leads to excessive daytime sleepiness, fatigue, inattentiveness resulting in traffic accidents. Obstructive sleep apnea (OSA) was accompanied by a 1.21 to 4.89-fold increase in risk for traffic accidents. Drivers with SRBD who did not adhere to their treatment were involved in five-fold more accidents than those who did. Glaucoma and SRBD are highly prevalent, and thus a strategy should include screening a broader range of the population. They potentially cause serious accidents in the workplace, especially for those working in transportation services. Both glaucoma and SRBD

| Table 1 Possible causes of health-related traffic accidents |
|----------------------------------------------------------|
| Ophthalmologic disorders (glaucoma, cataract, etc.)       |
| Sleep-related breathing disorders (SRBD)                  |
| Cardiovascular diseases (arrhythmias, infarctions, etc.)  |
| Neurological conditions (stroke, syncope, dementia, epilepsy, seizures, etc.) |
| Chronic respiratory failure                               |
| Otolaryngological disorders (vertigo, hearing loss, etc.) |
| Hypoglycemia                                              |
| Allergic disorders                                        |
| Drug-associated conditions                                |

Table 2 Glaucoma and sleep-related breathing disorders (SRBD) share the common characteristics of high prevalence, unrecognized symptoms and increased involvement of those affected in motor vehicle accidents (MVAs).

|                          | Glaucoma | SRBD                                      |
|--------------------------|----------|------------------------------------------|
| **Prevalence**           | 5%       | Women in their 50’s just under 10%       |
|                          |          | Men in their 50’s: 10–20%                |
| **Under-diagnosis**      | 50 ~ 90% | At least 80% of moderate or severe obstructive sleep apnea (OSA) among the middle-aged |
|                          |          | Excessive daytime sleepiness detected by the Epworth sleepiness scale (ESS) may fail to identify those with SRBD |
| **Fold increase in MVAs**| At-risk for accidents | OSA: 1.21 ~ 4.89 |

*Further evidence still needs to be established.*
are not always symptomatic\textsuperscript{23,24} and thus subjective assessment may not be trustworthy. In cases of glaucoma, the loss of optic nerve fibers starts not only long before it is sensed, but also before the defects can be detected by perimetry, and visual field defects rarely occur at the same area in both eyes\textsuperscript{23}. Therefore, patients may fail to notice their glaucoma-related visual field defects on their own before progression to a late stage when their central visual fields are affected\textsuperscript{23}.

Considering these common characteristics, general screening using objective assessment is effective and essential in workplaces when there is a high prevalence of the conditions underlying health-related accidents, subjective manifestations are scarce, or the consequences of accidents can be expected to be quite serious.

**Our approach to glaucoma to prevent HRTA:**

**CLOCK CHART®**

There are many individuals with latent glaucoma who need screening, appropriate diagnosis and treatment for prevention of traffic accidents. A simple screening method, which even busy generalists can use in their outpatient clinics, is urgently needed. CLOCK CHART® could be a handy visual field screening tool.

**CLOCK CHART® as a promising tool for prevention against HRTA**

CLOCK CHART® is a self-administered visual field screening tool\textsuperscript{25}. Illustrations of a ladybug, a caterpillar, a butterfly and a cat are depicted on circumferences of eccentricity zones 10°, 15°, 20° and 25° away from the center, respectively (Figure 1), when the examinee stares at the center from 35 cm above\textsuperscript{25}. Then, an examiner can identify visual field defects of examinees by confirming if the illustration remains visible to them as CLOCK CHART® rotates\textsuperscript{25} (Figure 2).

The sensitivity of visual field screening using CLOCK CHART® was 87\%, 93\%, and 97 \% for the mean defect (MD) value in early, moderate, and severe glaucoma, respectively (early <6 dB, moderate 6 dB≦MD≦12 dB and severe >12 dB), and the specificity was 89 \%. This high efficacy was confirmed by our preliminary study\textsuperscript{26}: the visual fields of 5 individuals with glaucoma were examined using both a Humphrey Field Analyzer and CLOCK CHART®. We divided the visual field of 5 patients into 4 areas, namely the superior and inferior areas of the right and left eyes. Of the 20 areas, the Humphrey Field Analyzer detected visual field defects in 60\% of the areas, while CLOCK CHART® detected defects in 45\%. Their agreement rate was 85\%. CLOCK CHART® binocular...
CLOCK CHART® is useful for accident by detection of visual field defects to prevent traffic accidents. CLOCK CHART® can be used to functionally assess vision. Non-ophthalmology physicians and surgeons should also screen visual fields of patients using CLOCK CHART® to identify those at-risk for the traffic accident by detection of visual field defects to prevent traffic accidents. CLOCK CHART® is useful for boosting awareness of glaucoma, leading to its diagnosis and treatment, and will help keep drivers with glaucoma safe.

Concluding Remarks

Among licensed drivers, glaucoma is distressingly prevalent and correlates with traffic accidents (health-related traffic accidents). General screening with CLOCK CHART® leads to appropriate and early diagnosis and treatment and care for glaucoma, which might promote safe driving.

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